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OF THE

NEW YORK ACADEMY OF SCIENCES.

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TRANSACTIONS

OF THE

NEW YORK ACADEMY OF SCIENCES

LATE

LYCEUM OF NATURAL HISTORY.

VOLUME X.

October, 1890, to June, 1891.

Edited by the RECORDING SECRETARY assisted by the PUBLICATION COMMITTEE.

NEW YORK:

PUBLISHED BY THE ACADEMY.

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1891–1892.

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CHARTER.

AN ACT TO INCORPORATE THE

LYCEUM OF NATURAL HISTORY

IN THE CITY OF NEW YORK.

Passed April 20th, 1818.

WHEREAS, The members of the Lyceum of Natural History have petitioned for an act of incorporation, and the Legislature, impressed with the importance of the study of Natural History, as connected with the wants, the comforts, and the happiness of mankind, and conceiving it their duty to encourage all laudable attempts to promote the progress of science in this State—therefore,

Be it enacted by the People of the State of New York, represented in Senate and Assembly, That Samuel L. Mitchill, Casper W. Eddy, Frederick C. Schaeffer, Nathaniel Paulding, William Cooper, Benjamin P. Kissam, John Torrey, William Cumberland, D'Jurco V. Knevels, James Clements, and James Pierce, and such other persons as now are, and may from time to time become members, shall be, and hereby are, constituted a body corporate and politic, by the name of LYCEUM OF NATURAL HISTORY IN THE CITY OF NEW YORK, and that by that name they shall have perpetual succession, and shall be persons capable of suing and being sued, pleading and being impleaded, answering and being answered unto, defending and being defended, in all courts and places whatsoever; and may have a common seal, with power to alter the same

from time to time; and shall be capable of purchasing, taking, holding, and enjoying, to them and their successors, any real estate in fee simple or otherwise, and any goods, chattels, and personal estate, and of selling, leasing, or otherwise disposing of said real or personal estate, or any part thereof, at their will and pleasure: *Provided always*, that the clear annual value or income of such real or personal estate shall not exceed the sum of five thousand dollars: *Provided*, however, that the funds of the said corporation shall be used and appropriated to the promotion of the objects stated in the preamble to this act, and those only.

2. *And be it further enacted*, That the said Society shall, from time to time, forever hereafter, have power to make, constitute, ordain, and establish such by-laws and regulations as they shall judge proper, for the election of their officers; for prescribing their respective functions, and the mode of discharging the same; for the admission of new members; for the government of the officers and members thereof; for collecting annual contributions from the members towards the funds thereof; for regulating the times and places of meeting of the said Society; for suspending or expelling such members as shall neglect or refuse to comply with the by-laws or regulations, and for the managing or directing the affairs and concerns of the said Society: *Provided* such by-laws and regulations be not repugnant to the Constitution and laws of this State or of the United States.

3. *And be it further enacted*, That the officers of the said Society shall consist of a President and two Vice-Presidents, a Corresponding Secretary, a Recording Secretary, a Treasurer, and five Curators, and such other officers as the Society may judge necessary; who shall be annually chosen, and who shall continue in office for one year, or until others be elected in their stead; that if the annual election shall not be held at any of the days for that purpose appointed, it shall be lawful to make such election at any other day; and that five members of the said Society, assembling at the place and time designated for that purpose by any by-law or regulation of the Society, shall constitute a legal meeting thereof.

4. *And be it further enacted*, That Samuel L. Mitchill shall be the President; Casper W. Eddy the First Vice-President; Frederick C. Schaeffer the Second Vice-President; Nathaniel Paulding, Corresponding Secretary; William Cooper, Recording Secretary; Benjamin P. Kissam, Treasurer, and John Torrey, William Cumberland, D'Jurco V. Knevels, James Clements, and James Pierce, Curators; severally to be the first officers of the said corporation,

who shall hold their respective offices until the twenty-third day of February next, and until others shall be chosen in their places.

5. *And be it further enacted*, That the present Constitution of the said Association shall, after passing of this Act, continue to be the Constitution thereof; and that no alteration shall be made therein, unless by a vote to that effect of three-fourths of the resident members, and upon the request in writing of one-third of such resident members, and submitted at least one month before any vote shall be taken thereupon.

State of New York, Secretary's Office.

I CERTIFY the preceding to be a true copy of an original Act of the Legislature of this State, on file in this Office.

ARCH'D CAMPBELL,
Dep. Sec'y.

ALBANY, *April 29th*, 1818.

ORDER OF COURT.

ORDER OF THE SUPREME COURT OF THE STATE OF NEW YORK

TO CHANGE THE NAME OF

THE LYCEUM OF NATURAL HISTORY IN THE CITY OF NEW YORK

TO

THE NEW YORK ACADEMY OF SCIENCES.

WHEREAS, in pursuance of the vote and proceedings of this Corporation to change the corporate name thereof from "The Lyceum of Natural History in the City of New York" to "The New York Academy of Sciences," which vote and proceedings appear of record, an application has been made in behalf of said Corporation to the Supreme Court of the State of New York to legalize and authorize such change, according to the statute in such case provided, by Chittenden & Hubbard, acting as the attorneys of the Corporation, and the said Supreme Court, on the 5th day of January, 1876, made the following order upon such application in the premises, viz.:

At a Special Term of the Supreme Court of the State of New York, held at the Chambers thereof, in the County Court House, in the City of New York, the 5th day of January, 1876:

Present—Hon. George C. Barrett, *Justice.*

In the matter of the application of the Lyceum of Natural History in the City of New York to authorize it to assume the corporate name of The New York Academy of Sciences.

On reading and filing the petition of the Lyceum of Natural History in the City of New York, duly verified by John S. Newberry, the President and chief officer of said Corporation, to authorize it to assume the corporate name of The New York Academy of Sciences, duly setting forth the grounds of the said application, and on reading and filing the affidavit of Geo. W. Quackenbush, showing that notice of such application had been duly published for six weeks in the State paper, to wit, *The Albany Evening Journal*, and the affidavit of David S. Owen, showing that notice of such application had also been duly published in the proper newspaper of the County of New York, in which county said Corporation has its business office, to wit, in the *Daily Register*, by which it appears to my satisfaction that such notice has been so published, and on reading and filing the affidavits of Robert H. Brownne and J. S. Newberry, thereunto annexed, by which it appears to my satisfaction that the application is made in pursuance of a resolution of the managers of said Corporation to that end named, and there appearing to me to be no reasonable objection to said Corporation so changing its name, as prayed in said petition: Now, on motion of Grosvenor S. Hubbard, of Counsel for Petitioner, it is

Ordered, That the Lyceum of Natural History in the City of New York be and is hereby authorized to assume the corporate name of The New York Academy of Sciences.

Indorsed: Filed January 5, 1876.

A copy. WM. WALSH, *Clerk.*

Resolution of THE ACADEMY, *accepting the order of the Court, passed February* 21, 1876.

And whereas, The order hath been published as therein required, and all the proceedings necessary to carry out the same have been had, Therefore:

Resolved, That the foregoing order be and the same is hereby accepted and adopted by this Corporation, and that in conformity therewith the corporate name thereof, from and after the adoption of the vote and resolution hereinabove referred to, be and the same is hereby declared to be

THE NEW YORK ACADEMY OF SCIENCES.

CONSTITUTION.

ARTICLE I.

This Society shall be styled The New York Academy of Sciences.

ARTICLE II.

It shall consist of four classes of members, namely: resident members, corresponding members, honorary members, and fellows. Resident members shall be such as live in or near the City of New York; corresponding members, such as reside at a distance from said city; and honorary members, such as may be judged worthy, from their attainments in science, to be admitted into the Academy. The number of honorary members shall not exceed fifty. Fellows shall be chosen from among the resident members, in virtue of scientific attainments or services.

ARTICLE III.

All fellows and members shall be elected by ballot. The names of candidates shall be proposed in writing, at least two meetings previous to being balloted for. The affirmative votes of three-fourths of the fellows and members present shall be necessary to elect a candidate; honorary or corresponding members, however, may be elected without previous notice, provided that the ballot on such election is unanimous.

ARTICLE IV.

None but fellows or resident members shall be entitled to vote in the Academy.

ARTICLE V.

No fellow or member who shall be in arrears for one year shall be entitled to vote or be eligible to any office in the Academy.

ARTICLE VI.

The officers of the Academy shall consist of a president, a first and second vice-president, a corresponding secretary, a recording secretary, a treasurer, five curators, and a librarian, who shall be chosen annually on the fourth Monday in February.[1] The president, vice-presidents, and secretaries shall be fellows. There shall also be elected, at the same time, a finance committee of three.

ARTICLE VII.

There shall be elected at the annual meeting six members, at least three of whom shall be fellows, who, together with the president, the vice-president, the two secretaries, and the treasurer, shall constitute a Council, by whom all business, to be brought before the Academy, shall ordinarily be prepared. Vacancies occurring in the offices or in the Council of the Academy in the interval between the annual elections, may be filled for the unexpired term by special election at any regular business meeting, provided notice of such election shall have been given at a previous regular business meeting.

ARTICLE VIII.

The election of officers and of the Council shall be by ballot, and the candidates having the greatest number of votes shall be declared duly elected.

ARTICLE IX.

Five members at an ordinary meeting shall form a quorum, and ten at a special or business meeting, a majority of whom, in either case, shall be fellows.

ARTICLE X.

By-laws for the further regulation of the Society may from time to time be made.

---

[1] See eighth line of Section 3 of the Charter.

ARTICLE XI.

[1] No alteration shall be made in this Constitution, unless by a vote to that effect of three-fourths of the fellows and three-fourths of the resident members entitled to vote under Article V.

---

[1] This clause must be taken in connection with Section 5 of the Charter, which requires a previous request in writing of one-third of all the resident members (which must be considered in this case as including fellows, as that class of members was not in existence at the time the Charter was granted), submitted one month previous to any vote being taken.

BY-LAWS.

Chapter I.—*Of Members and Fellows.*

1. Persons elected to resident membership shall pay their initiation fees within three months from date of election, or said election shall be void. No member in arrears shall be eligible as a fellow.

2. A resident member or fellow removing from the city, and not in arrears, may become a corresponding member; and a corresponding member who removes to the city may become a resident member on paying the initiation fee. The Recording and Corresponding Secretaries shall have power to arrange the transfer, and shall notify the Treasurer.

3. Only persons engaged in the pursuit of some branch of science shall be eligible to corresponding membership.

Chapter II.—*Of Original Subscriptions.*

1. Every holder (whether original subscriber, transferee, or legatee) of a receipt for the sum of one hundred dollars, paid into the treasury of the New York Lyceum of Natural History towards the liquidation of the debt incurred by the erecting of the building formerly the property of the Lyceum, in Broadway, in this city, shall be entitled for himself and his family to free admission to such public lectures as may be delivered on its behalf, which the members have a right to attend. He shall be entitled to the use of the books of the Library, in accordance with the regulations of the Academy.

Chapter III.—*Of Patrons and Life-Members.*

1. Any person, by contributing, at one time, two hundred and fifty dollars to the fund for the general purposes of the Academy, becomes a patron, and shall, during life, be entitled to the same privileges as an original subscriber, and shall be entitled to one copy of all the publications of the Academy appearing subsequent to the date of the payment.

2. Any resident member may become a life-member by contributing, at one time, one hundred dollars toward the fund for the general purposes of the Academy, and shall thereafter be exempt from annual dues, and shall be entitled to one copy of all the publications of the Academy issued subsequent to date of the payment.

3. All contributions received under the provisions of this Chapter shall be invested in the same manner as the publication fund ; the income derived therefrom shall be applied to the general purposes of the Academy.

Chapter IV.—*Of Officers.*

1. The President, or, in his absence, one of the Vice-Presidents, or, in their absence, a Chairman *pro tempore*, shall preside at all meetings of the Academy, and shall have a casting vote. He shall appoint all committees authorized by the Academy, unless otherwise specially ordered.

2. The Corresponding Secretary shall be charged with the correspondence of the Academy. He shall keep a record of the corresponding members; shall notify corresponding and honorary members of their election; and shall report to the Academy on the fourth Monday of February, annually, the state of its correspondence.

3. The Recording Secretary shall be present at the meetings of the Academy, and shall keep a record of the proceedings thereof. He shall have charge of all papers and documents belonging to the Academy; shall keep a corrected list of members and fellows; shall send to resident members and fellows announcements of the meetings of the Academy; shall notify all resident members and fellows of their election, and committees of their appointment; shall give notice to the Treasurer and to the Council of matters requiring their action; and shall bring before the Academy business presented by the Council. He may employ an Assistant at a salary to be determined by the Council.

4. The Treasurer shall have charge of all moneys belonging to the Academy, and, under direction of the Council, of their investment. He shall collect initiation fees and annual dues from all members and fellows, all subscriptions made in behalf of the Academy, and any income that may accrue from property belonging to the institution; shall report to the Council meeting in January the names of members in arrears; shall keep the property of the Academy insured, and pay all debts against the Academy the discharge of which shall be ordered by the Council. He shall re-

port to the Council from time to time the state of the finances, and to the Academy, on the fourth Monday of February, the receipts and expenditures of the entire year.

5. The Librarian shall have immediate supervision and care of the Library, under the general authority of the Library Committee of the Council, and shall conduct all correspondence respecting the exchanges of the Academy. On the fourth Monday in February he shall make an Annual Report on the condition of the Library.

6. The Curators shall be assigned to their respective duties by the Council.

Chapter V.—*Of the Council.*

1. The President, Vice-Presidents, and Secretaries of the Academy shall hold the same offices in the Council.

2. The Council shall meet at least once a month, preceding the regular business meeting of the Academy. Minutes shall be kept of its proceedings by the Recording Secretary.

3. Five members of the Council, a majority of whom shall be fellows, shall constitute a quorum; but business may be transacted at a regularly called meeting of the Council at which less than a quorum is present, subject to the written approval of a majority of the Council, subsequently given to the Secretary, and recorded by him with the minutes.

4. The Council shall transact all business referred to it by the Academy, and prepare any other business at its discretion.

5. The Council shall organize within itself a Committee on Nominations, a Committee on Publication, and a Committee on the Library, to whom, in the intervals of the meetings of the Council, all matters pertaining to these several subjects shall be referred. Their action shall always be subject to the revision of the Council.

Chapter VI.—*Of the Finance Committee.*

1. The Finance Committee shall have the duties and powers of a Committee of Ways and Means. They shall audit the annual report of the Treasurer, and shall report on financial questions referred to them, whenever called upon to do so by the Academy or by the Council.

Chapter VII.—*Of Sections.*

1. Sections of special branches of science may be established or abolished by the Academy upon the recommendation of the Council and one month's notice.

2. Sections shall be organized with at least a Chairman and a

Secretary, and these officers may take charge of the meeting of their section during the presentation of its scientific business.

Chapter VIII.—*Of Initiation Fees, Annual Dues, etc.*

1. Every resident member, within three months after his election, shall pay an initiation fee of five dollars. All members who become fellows shall pay a fellowship fee of ten dollars. The annual dues of resident members and fellows shall be ten dollars.

2. Honorary and corresponding members, and patrons, as well as any resident member or fellow coming under the provisions of Chapter II., shall be exempt from initiation fees and annual dues.

3. The Academy may, on account of services, exempt any member or fellow from his annual dues, provided the proposal be made at a regular business meeting, be approved by the Council, lie over until the next regular business meeting, and all the members then present agree thereto.

4. If any resident member or fellow, in arrears for his annual dues for over one year, shall neglect or refuse to pay the same within three months after notification by the Treasurer, his name may be erased from the rolls by a two-thirds vote of the Council.

Chapter IX.—*Of the Publications and Publication Fund.*

1. The publications of the Academy shall consist of the Annals and the Transactions, and such other documents as shall be ordered by the Council; they shall be issued under the supervision of Editors appointed by the Council, aided by the Committee of Publication. One copy of these publications shall be furnished free to each resident member and fellow not in arrears of dues more than six months.

2. Contributions may be received towards establishing a Publication Fund; all such contributions shall be invested in United States or in New York State securities, or in first mortgages on New York and Brooklyn real estate, provided they shall not exceed sixty-five per cent of the value of the property; and the income thereof shall be applied toward defraying the expenses of the scientific publications of the Academy.

3. Non-members and corresponding members contributing to the Publication Fund one hundred dollars or more, at one time, shall be entitled to one copy of all the scientific publications of the Academy appearing subsequently to the dates of the payment of their contributions.

Chapter X.—*Of the Library.*

1. The Library shall be under the control of the Librarian and the Library Committee.

2. No book shall be removed without consent of the Librarian, who shall keep a record of books loaned.

3. Not more than two works at one time may be loaned to one member or fellow without special permission from the Council.

4. On the first Monday in June, all books shall be called in; and the Library Committee shall examine the Library, and compare it with the catalogue. They shall note all missing books, and report the same, at the next meeting, to the Academy.

Chapter XI.—*Of Meetings.*

1. The ordinary meetings shall be held on Monday evenings in each month from the first of October to the beginning of June.

2. The Council may call a special meeting, provided a notice be sent to each resident member and fellow, stating the time at which such meeting is to be held, and the object for which it is called.

3. The meeting held on the fourth Monday in February shall be considered a special business meeting.

Chapter XII.—*Of Business.*

1. All business other than such as relates immediately to the cultivation of science shall be transacted at the first meeting of each month only, except when the Council shall report it as urgent.

2. The following shall be considered the regular order of procedure at the ordinary meetings:

1. Reading the minutes.
2. Reports of committees.
3. Exhibition of specimens.
4. Presentation and discussion of papers previously announced.
5. Any other scientific communications.

3. The following shall be considered the order of procedure at the regular business meetings:

1. Reading the minutes of the preceding business meeting.
2. Report of the Council.
3. Reports of Officers.
4. Reports of Committees.
5. Elections.

6. Deferred business.
7. New business.
8. Scientific communications.

4. The Rules of Order as set forth in "Cushing's Manual of Parliamentary Practice" shall be accepted as authoritative in the meetings of the Academy.

Chapter XIII.—*Of Elections.*

1. The Annual Elections shall be conducted as follows:

Nominations may be sent in writing to the Recording Secretary, with the names of the proposers, at any time not less than thirty days before the Annual Meeting; and the Council shall prepare, from the names so proposed, a list which shall constitute the regular ticket. This list shall be furnished to every resident member and fellow at least two weeks before the Annual Election. But any resident member or fellow shall be at liberty to alter this list, or to prepare another.

The election of officers and Councillors shall be by ballot. A list of the persons who have received the greatest number of votes of those present, certified by the tellers, shall then be presented by them to the presiding officer, who shall thereupon declare the said persons elected to their respective offices, and shall present the list to the Recording Secretary, who shall enter it on the minutes.

2. Resident and corresponding members shall be elected as follows: The candidates shall be proposed publicly, in writing, at any meeting, by a fellow or member; and the nominations, together with the name of the person making them, shall be referred to the Council; if approved by the Council, the candidates may be elected by ballot at any succeeding business meeting, observing always the provisions of Article III. of the Constitution.

3. Fellows shall be elected as follows: Candidates shall be recommended to the Council in writing, with the reasons for such recommendation, signed by the proposer; then the Council may publicly nominate them at a regular business meeting. They shall be balloted for at any succeeding business meeting, in the same manner as resident members.

4. Names of candidates for honorary membership shall be presented by the Council, and they shall be balloted for at a regular business meeting; a three-fourths vote of the members and fellows present being required to elect.

Chapter XIV.—*Of General Provisions.*

1. No expenditure shall be made on behalf of the Academy, unless authorized by a vote of the Council.

2. All bills submitted to the Council must be approved by the officers incurring them.

3. Any member or fellow may be censured, suspended, or expelled, for violation of the Constitution or By-Laws, or for any other offence deemed sufficient, by a vote of three-fourths of the members and three-fourths of the fellows present at any regular business meeting; *provided* that such action shall have been recommended by the Council at a regular business meeting, and one month's notice of such recommendation, and of the offence charged, shall have been given the member accused.

4. No alteration shall be made in these By-Laws, unless such alteration be submitted publicly in writing, at a regular business meeting, be entered on the minutes with the names of the members or fellows proposing the same, and be adopted by two-thirds of the members and two-thirds of the fellows present at a subsequent regular business meeting.

PATRONS OF THE ACADEMY.[1]

[Those marked with an asterisk are deceased.]

* Bland, Thomas,
Bolton, Prof. H. Carrington,
* Brevoort, J. Carson,
Casey, Thomas L., U. S. A.
Cotheal, Alex. J.,
* Delafield, Joseph,
* Dinwiddie, Robert,
Dodge, William E.,
Egleston, Prof. Thos.,
* Elsberg, L., M.D.,
Field, C. de Peyster,
Greene, J. W., M.D.,
Grinnell, Geo. B.,
Hinton, John H., M.D.,
Lawrence, Geo. N.,
Leeds, Prof. Albert R.,
* Lenox, James,
* Livingston, Robert J.,
Newberry, J. S., M.D.,
Prime, Frederick E.,
Prime, Temple,
Sloan, Samuel,
Steward, D. Jackson,
* Storrs, Charles,
* Stuart, Robert L.,
* Suckley, Geo., M.D.,
* Van Nostrand, H. D.,
* Van Rensselaer, Alex.,
Weston, Henry,
* Wheatley, Charles M.,
* Wolfe, Miss Catherine L.

CONTRIBUTORS TO THE PUBLICATION FUND.[2]

[Those marked with an asterisk are deceased.]

Amend, Bernard G.,
American Bank Note Co., A. D. Shepard, Vice-Prest.,
Chamberlain, W. L.,
Coddington, T. B.,
Collingwood, F.,
* Crosby, Rev. Howard,
Dodge, Wm. E.,
* Elsberg, L., M.D.,
Herrman, Mrs. H.,
Hildenbrand, W.,
Hoe, Henry,

[1] See By-laws, Chapter III., and Chapter VIII. Section 2.
[2] See By-laws, Chapter IX.

Julien, Alexis A.,
Krotel, Rev. G. F.,
Lawrence, Geo. N.,
Le Comte, Joseph,
* Lenox, James,
Lord, Franklin B.,
Prime, Temple,
Pyne, Percy R.,
Newberry, J. S., M.D.,
Redfield, John H.,
* Reinhart, B. F.,
Schuyler, Philip,
* Stengel, Prof. Fred.,
Steward, D. Jackson,
* Stuart, Robert L.,
Van Beuren, Fred. T.,
Waller, Elwyn,
Weston, Edward W.,
* Wolfe, John D.

RESIDENT FELLOWS AND MEMBERS.

[Fellows in italic ; Resident Members in roman.]
P, Patrons. S, Subscribers to Building Fund.

ELECTED

1878 Abbott, Frank, M.D., 22 West 40th Street.
1874 *Allen, Prof. J. A.*, American Museum of Natural History.
1867 *Allen, T. F., M.D.*, 10 East 36th Street.
1866 *Amend, B. G.*, 120 East 19th Street.
1880 *Arnold, E. S. F., M.D.*, 11 West 34th Street.
1886 Atterbury, Rev. Anson P., 117 West 87th Street.

1868 Bailey, James M., 77 Madison Avenue.
Banks, David S., 267 Fifth Avenue.
1871 Beach, Alfred E., 361 Broadway.
1868 *Beck, Fanning C. T.*, 78 East 56th Street.
1878 Bernacki, Charles, M.D., 36 West 28th Street.
1873 *Bickmore, Prof. A. S.*, Amer. Museum of Natural History.
1876 Bien, Julius, 139 Duane Street.
1878 Biggs, Charles, 610 Broadway.
1867 *Bolton, H. Carrington, Ph.D.*, University Club, **P.**
1885 Bonnett, Chas. P., Elizabeth, N. J.
1880 *Britton, N. L., Ph.D.*, Columbia College.
1887 *Brown, Hon. Addison*, 233 East 48th Street.
1869 *Brownell, Silas B.*, 322 West 56th Street.
Brownne, John S., 17 West 43d Street.
1888 Brush, Prof. Chas. B., 319 West 56th Street.

1887 *Casey, Capt. Thomas L.*, Army Building, Whitehall St., **P.**
1869 *Caswell, John H.*, 11 West 48th Street.
1865 *Chandler, Prof. Charles F.*, Columbia College.
1887 Cheney, Alfred C., Garfield Nat. Bank, 23d St. & 6th Ave.
1874 *Chittenden, L. E.*, 49 East 65th Street.
1888 Church, Benjamin S., 54 West 12th Street.
1877 Close, S. L., M.D., 48 East 31st Street.

ELECTED

1883 Colby, Charles E., Columbia College.
1871 *Collingwood, Francis, C.E.*, Elizabeth, N. J.
1889 Congdon, Ernest A., 31 Broadway.
1869 Conklin, W. A., Arsenal Building, Central Park.
1876 Conkling, Alfred R., 27 East Tenth Street.
1887 Constant, S. Victor, 405 West 21st Street.
1867 Cooper, Hon. Edward, 12 Washington Square.
1889 Corning, Jasper E., 69 E. 54th Street.
1847 *Cotheal, Alexander J.*, 62 West 36th Street, **P.**
1876 *Cox, Charles F.*, 100 East 17th Street.
1867 *Crooke, John J.*, 165 Mulberry Street.

1868 *Daly, Hon. Charles P.*, 84 Clinton Place.
1876 Davies, William G., 32 Nassau Street.
1868 *Day, Prof. Edward H.*, 1187 Lexington Avenue.
1888 *Dean, Bashford, Ph.D.*, College of the City of New York.
1877 Dederick, E. H., 18 Maiden Lane.
1882 Devoe, Frederick W., P. O. Box 460.
1884 Dewitt, William G., 88 Nassau Street.
1880 Diehl, Mrs. Anna Randall, 56 West 55th Street.
1878 Dittenhoefer, A. J., 96 Broadway (Room 140).
1877 Dix, Rev. Morgan, D.D., 27 West 25th Street.
1867 Dodge, William E., 262 Madison Avenue, **P.**
1876 *Doremus, Charles A., Ph.D.*, 92 Lexington Avenue.
1867 *Doremus, Prof. R. Ogden, M.D.*, 241 Madison Avenue.
1881 *Douglass, Andrew E.*, 9 East 54th Street.
1890 Dow, Lorenzo, 180 West 59th Street.
1877 Drummond, Isaac W., 101 Horatio Street.
1872 Drummond, James F., 436 West 22d Street.
1876 Du Bois, Eugene, 23 Park Row.
1884 *Dudley, Henry*, 56 West 57th Street.
1884 *Dudley, P. H.* (Room 21) Grand Central Station.
1890 Dunham, E. K., 53 East 30th Street.
1888 Dwight, Jonathan, Jr., 2 East 34th Street.

1888 *Edison, Thomas A.*, Orange, N. J.
1861 *Egleston, Prof. Thomas*, 35 West Washington Square, **P.**

ELECTED

1885 *Elseffer, William L., C.E.*, 18 Broadway.
1891 English, Geo. L., 733 Broadway.
1890 Eyerman, John, Easton, Pa.

1878 Fargo, James C., 56 Park Avenue.
1888 Farrar, Dr. John N., 1271 Broadway.
1869 Field, C. de Peyster, 21 East 26th Street, **P.**
1881 Fischer, Charles S., Jr., M.D., 110 West 128th Street.
1864 Fish, Hon. Hamilton, 251 East 17th Street, **S.**
1889 Fiske, Thomas Scott, Columbia College.
Friedrich, James J., M.D., 124 East 59th Street.

1890 Garrettson, Francis T., 26 Broad Street.
1889 Gibson, W. W., P. O. Box 1449, New York City.
1890 Goldschmidt, S. A., Ph.D., 12 East 58th Street.
Gould, George, 1 East 47th Street.
1867 Gouley, J. W. S., M.D., 324 Madison Avenue.
1884 Gratacap, Louis P., American Museum of Natural History.
1865 Green, Hon. Andrew H., 214 Broadway.
1890 Greene, Dr. Jeannette B., 56 West 55th Street.
1871 Grinnell, George B., 41 Park Row, **P.**

1869 Hale, Albert W., 280 Broadway.
1888 Hall, Prof. Robert W., 712 Fifth Avenue.
1881 Hamilton, Rev. Samuel M., 62 West 11th Street.
1878 Hartt, James C., 21 Cortlandt Street.
1881 Hascall, Mrs. Virginia K., 110 East 16th Street.
1876 Haswell, Charles H., 42 Broadway.
1880 Heineman, Henry N., M.D., 49 West 57th Street.
1888 Henderson, John C., care of R. B. Poole, 108 W. 40th St.
1881 Herrman, Mrs. Esther, 59 West 56th Street, **P.**
1868 *Hewitt, Hon. Abram S.*, 9 Lexington Avenue.
1890 Higgins, J. Foster, 50 Wall Street.
1877 Hildenbrand, William, 222 West 24th Street.
1876 Hildreth, D. M., 48 Irving Place.
1865 *Hinton, John H., M.D.*, 41 West 32d Street, **P.**
1881 *Hitchcock, Miss F. R. M.*, Hotel Beresford, 81st Street, Central Park West.

ELECTED

1881 Hitchcock, Hiram, Fifth Avenue Hotel.
1886 Holbrook, Levi, 128 West 59th Street.
1878 Hoe, Henry, 91 John Street.
Hooper, Prof. Franklin W., 71 St. James Place, Brooklyn.
1878 Hoyt, Alfred M., 1 Broadway.
1874 *Hubbard, Prof. O. P., M.D.,* 65 West 19th Street.
1876 Hubbard, Walter C., 27 West Ninth Street.
1881 Hyde, E. Francis, 54 Wall Street.

1876 Ireland, John B., 170 Broadway.

1867 *Jacobi, Abram, M.D.,* 110 West 34th Street.
1887 *Jacoby, L. H.,* Columbia College.
1876 James, D. Willis, 40 East 39th Street.
1836 Jay, Hon. John, 242 East 15th Street, **S.**
1878 Jay, John C., M.D., 17 West 46th Street, **S.**
1867 *Julien, Alexis A., Ph.D.,* Columbia College.

1884 Ketchum, Mrs. A. C., 19 Lafayette Place.
1878 Kimber, Rev. Arthur C., 105 East Houston Street.
1878 *King, Prof. Clarence,* Brevoort House.
1876 *Kunz, George F.,* Hoboken, N. J.

1884 *Lamborn, R. H., Ph.D.,* care of Mexican Nat. R. R. Co., 32 Nassau Street.

1890 Lamb, Osborn R., 356 West 22d Street.
1881 *Laudy, Louis H., Ph.D.,* Columbia College.
Law, Walter W., Grolier Club, 29 East 32d Street.
1845 *Lawrence, George N.,* 45 East 21st Street, **P.**
1878 Le Comte, Joseph, 231 Front Street.
1888 *Ledoux, Albert R., Ph.D.,* 39 West 50th Street.
1868 Lee, J. Lawrence, M.D., 21 West 17th Street.
1872 *Leeds, Prof. A. R.,* Stevens Institute, Hoboken, N. J., **P.**
1872 *Levison, Dr. W. Goold,* 314 Livingston St., Brooklyn, N. Y.
1885 Lewis, W. H., Jr., 63 West 19th Street.
1869 Liautard, A., M.D., 141 West 54th Street.
1876 Lichtenstein, Paul, Cotton Exchange Building, N. Y.
Lindley, C. L., M.D., 85 Madison Avenue.

ELECTED

1885 Lord, Benjamin, M.D., 34 West 28th Street.
1876 Low, Hon. Seth, Columbia College.

1878 Marble, Manton, 532 Fifth Avenue.
1876 *Marquand, Henry G.*, 11 East 68th Street.
1868 *Martin, Prof. Daniel S.*, 236 West Fourth Street.
1882 Martin, Edward W., 256 West 57th Street.
1881 Maynard, Prof. George W., 31 Nassau Street.
1875 McCarty, Edwin R., 246 West 58th Street.
1889 *McClintock, Emory*, Mutual Life Ins. Co., N. Y.
1882 *McDonald, John*, 11 Pine Street.
1885 Mead, Walter H., 65 Wall Street, **P.**
Merrill, Fred. J. H., Ph.D., New York State Museum, Albany, N. Y.
1876 Mitchell, Edward, 31 East 50th Street.
Mitchell, John Murray, 43 Wall Street.
1876 *Moore, Gideon E., Ph.D.*, 221 Pearl Street.
1881 Morse, J. H., 423 Madison Avenue.
1874 Mott, Henry A., Jr., Ph.D., 100 Broadway.
1878 Mulcahey, Rev. James, 65 Church Street.
1885 Munsell, C. E., Ph.D., 223 West 14th Street.

1852 *Newberry, Prof. J. S., M.D.*, Columbia College, **P.**
1871 *Newton, H. J.*, 128 West 43d Street.
1891 Niven, William, 741 Broadway.
1878 Nott, F. J., M.D., 522 Madison Avenue.

1878 Ottendorfer, Oswald, 7 East 17th Street.

1879 Parmly, D. D., 160 Broadway.
1881 Parsons, William Barclay, Jr., 51 East 53d Street.
1888 Patten, John, care of John Ryan Co., Baltimore, Md.
1879 Peabody, Hon. Charles A., 60 West 21st Street.
1883 *Pellew, Charles E.*, 51 East 54th Street.
1878 Phelps, Hon. William W., 2 Wall Street.
1884 *Pitkin, Lucius, Ph.D.*, 138 Pearl Street.
1885 *Poggenburg, Justus F.*, 439 East 57th Street.
1891 Post, C. A., 21 North Washington Square.

ELECTED

1877 Potter, Rt. Rev. Henry C., 160 West 59th Street.
1889 Potter, Orlando B., Potter Building, Park Row.
1890 Prentice, Charles F., 178 Broadway.
1864 Prime, F. E., 26 Broad Street, **P.**
1852 Prime, Temple, 26 Broad Street, **P.**
1890 Pupin, M. I., Ph.D., 68 West 72d Street.
1878 Pyne, Percy R., 52 Wall Street.

1890 Quackenbos, Prof. J. D., Columbia College.

Rawson, A. L., Broadway and 58th Street.
1882 *Rees, Prof. John K.*, Columbia College.
1876 Rice, Charles, Ph.D., Bellevue Hospital.
1871 *Ricketts, Pierre de P., Ph.D.*, Columbia College.
1888 Rickoff, Andrew J., LL.D., 40 West 59th Street.
1890 Riley, R. Hudson, 131 St. John's Place, Brooklyn.
1884 Ripley, John H., M.D., 605 Lexington Avenue.
1888 Roosevelt, Frank, 58 West 15th Street.
1887 *Rusby, Henry H., M.D.*, 254 Clinton Ave., Newark, N. J.
1889 Rusby, John M., Jersey City Gas Works, Jersey City, N. J.
1880 Russell, Wm. H., 21 West Tenth Street.
1864 *Rutherford, Lewis M.*, 16 Exchange Place.

1864 Satterlee, F. Leroy, M.D., 21 West 19th Street.
1859 Satterlee, Livingston, 58 Cedar Street.
1867 Schermerhorn, F. A., 61 University Place.
1875 Schoeney, L., M.D., 68 East 104th Street.
1888 Schoonmaker, W. D., 28 Warren Street.
1878 Schultz, Carl H., 440 First Avenue.
1876 Schuyler, Philip, 18 North Washington Square.
1876 Serrell, Lemuel W., 140 Nassau Street.
1878 Shriver, Walter, 333 East 56th Street.
1877 Sieberg, W. H. J., 158 East 124th Street.
1890 Skeel, Dr. Frank D., 361 Mott Avenue.
1876 Sloan, Samuel, 26 Exchange Place, **P.**
1876 *Smith, S. Hanbury, M.D.*, 309 Broadway.
1890 Smith, Sydney T., University Club.
1890 Starr, Dr. Frederick, Amer. Museum of Natural History.

ELECTED

1882 Stevens, George F., M.D., 33 West 33d Street.
1882 *Stevens, Prof. W. Le Conte,* Packer Institute, Brooklyn.
1880 *Stevenson, Prof. J. J.,* University of the City of New York
1858 Steward, D. Jackson, 20 Gramercy Park, **P.**
1868 Stuyvesant, Rutherfurd, 246 E. 15th Street.
1890 Sutro, Mrs. Matilda, 60 West 49th Street.

1890 *Tatlock, John, Jr.,* P. O. Box 194.
1876 *Taylor, Charles Fayette, M.D.,* 201 West 54th Street.
1877 Taylor, Henry L., M.D., 201 West 54th Street.
1883 Terry, James, American Museum of Natural History.
1878 Todd, A. J., 261 Broadway.
Tows, C. D., 1326 19th Street, Washington, D. C.
1875 Trotter, Alfred W., 112 East 127th Street.
1878 *Trowbridge, Prof. Wm. P.,* Columbia College.

1882 Valentini, Philip, Ph.D., 249 West 23d Street.
1880 Van Beuren, Fred. T., 21 West 14th Street.
1876 *Van Brunt, Cornelius,* 319 East 57th Street.
1878 Van Slyck, George W., 120 Broadway.
1890 *Vulté, H. T., Ph.D.,* Columbia College.

1879 *Wall, John L.,* 388 Sixth Avenue.
1871 *Waller, Elwyn, Ph.D.,* Columbia College.
1888 Warren, Miss Lillie E., 239 West 21st Street.
1888 Watson, B. A., 124 York Street, Jersey City, N. J.
1865 Weston, Henry, 31 Nassau Street, **P.**
1881 White, James H., 14 West 39th Street.
1879 *Whitfield, Prof. R. P.,* Amer. Museum of Natural History.
1882 *Wiechmann, Ferd. G., Ph.D.,* Columbia College.
1876 Wiener, Joseph, M.D., 150 East 61st Street.
1878 Wood, Isaac F., Rahway, N. J.
1865 Wood, William H. S., 8 East 63d Street.
1869 Wurtz, Prof. Henry, 2142 Seventh Avenue.

1877 *Youmans, William J., M.D.,* 3 Bond Street.

CORRESPONDING MEMBERS.

	ELECTED
Abbe, Prof. Cleveland, Washington, D. C.	
Abbott, Dr. Chas. C., Trenton, N. J.	1883
d'Achiardi, Prof. Antonio, University of Pisa, Italy	1883
Adams, Rev. H. M., Gaboon, Africa	1854
Agassiz, Alexander, Cambridge, Mass.	1866
Alexander, Prof. W. D., Honolulu, Hawaiian Islands	1890
Am Ende, Dr. C. G., Hudson City, N. J.	1874
Angas, Geo. French, London, England	1864
Appleton, Prof. John H., Providence, R. I.	1876
Archbald, Andrew, Paris, France	1852
Austen, Prof. Peter T., New Brunswick, N. J.	1878
Ayres, Dr. W. O., New Haven, Conn.	1864
Balch, Geo. T., New York, N. Y.	1876
Ball, Prof. Valentine, Dublin, Ireland	1885
Barclay, Robert, England	1830
Bard, John, Tours, France	1836
Batchelder, John M., Cambridge, Mass.	1854
Bayle, Prof. E., School of Mines, Paris, France	1868
Beadle, E. L., M.D., Poughkeepsie, N. Y.	1835
Bechler, Lieut. W. H., Newport, R. I.	1880
Bell, J. Graham, Boston, Mass.	1878
Bell, James H., Sandusky, O.	1836
Bennet, Rev. Cephas Tavoy, Burmah	1847
Berthoud, Edw. L., Golden City, Col.	1867
Bertrand, Prof. Émile, Rue de Tournon, Paris, France	1883
Binney, W. G., Burlington, N. J.	1857
Bishop, Nath. H., Lake George, N. Y.	1869
Boissier, E., Geneva, Switzerland	1852
Bolles, Rev. E. C., Salem, Mass.	1865

	ELECTED
Bolton, Dr. Meade, Richmond Hill, N. Y.	1890
Bombicci, Prof. Luigi, University of Bologna, Italy	1883
Boni, Giacomo, Venice, Italy	1886
Brandegee, Townsend S., Cañon City, Col.	1874
Branner, Prof. J. C., Little Rock, Ark.	1884
Brewster, Wm., Cambridge, Mass.	1874
Brockett, L. P., M.D., Hartford, Conn.	1847
Brown, Rev. Samuel R., S.T.D., Yokohama, Japan	1859
Brunet, Dr., Bahia, Brazil	1867
Brush, Prof. Geo. J., New Haven, Conn.	1876
Buck, C. Elton, Wilmington, Del.	1866
Caldwell, Prof. Geo. C., Ithaca, N. Y.	1876
Carmichael, Prof. Henry, Boston, Mass	1876
Cary, Prof. Albert A., Bridgeport, Conn.	1890
Castelnau, Count, Paris, France	1839
Castillo, Prof. Antonio del, Mexico City, Mexico	1890
Chandler, Prof. W. H., Bethlehem, Pa.	1876
Chapman, A. W., M.D., Apalachicola, Fla.	1836
Chapman, Prof. E. J., Toronto, Canada	1877
Chester, Prof. Albert H., Clinton, N. Y.	1877
Christy, David, Baltimore, Md.	1852
Clark, Thomas, Bristol, England	1827
Clarke, Prof. F. W., Washington, D. C.	1876
Clay, Joseph A., Philadelphia, Pa.	1857
Collett, Prof. John, Indianapolis, Ind.	1880
Comstock, Prof. Theo. B., Champaign, Ill.	1877
Cooke, Prof. Josiah P., Jr., Cambridge, Mass.	1876
Cooke, Dr. M. C., London, England	1868
Cooper, Dr. James G., Hayward, Cal.	1855
Cope, Prof. Edward D., Philadelphia, Pa.	1876
Cornwall, Prof. H. B., Princeton, N. J.	1876
Cory, Charles B., Boston, Mass.	1880
Cox, Kenyon, Anaheim, Cal.	1880
Crawford, Jos. A., Davenport, Iowa	1877
Credner, Prof. Hermann, Leipsic, Saxony	1866
Crosse, H., Paris, France	1864
Dale, T. Nelson, Toronto, Canada	1879
Dall, Prof. William H., Washington, D. C.	1870
Dana, Arnold Guyot, Brooklyn, N. Y.	1887

ELECTED

Dana, Prof. Edw. S., New Haven, Conn..... 1885
Deane, Ruthven, Cambridge, Mass..... 1874
Denning, W. H., Fishkill, N. Y..... 1832
Derby, Prof. Orville A., Rio Janeiro, Brazil..... 1890
Divine, Dr. S. R., Lake Sheldrake, N. Y..... 1867
Doubleday, Edward, Epping, England..... 1838
Douglass, Prof. Silas H., Ann Arbor, Mich..... 1876
Dow, Capt. John M., New York..... 1869
Drown, Prof. Thomas M., Boston, Mass..... 1876
Drummond, Prof. Henry, Glasgow, Scotland..... 1887
Dubois, Henry A., M.D., New Haven, Conn..... 1836
Duns, Prof. John, Edinburgh, Scotland..... 1868

Eaton, Prof. Daniel C., New Haven, Conn..... 1860
Edsall, Burroughs, Spuyten Duyvil, N. Y..... 1884
Edwards, Dr. Arthur M., Newark, N. J..... 1873
Elliot, Daniel G., New York City..... 1860
Elliot, Henry W., Washington, D. C..... 1876
Elliott, Prof. John B., Sewanee, Tenn..... 1880
Engelhardt, Dr. Francis E., Syracuse, N. Y..... 1869
Ernst, Dr. Adolfo, Caracas, Venezuela..... 1878

Fairbank, Rev. W., East Indies..... 1853
Fairchild, Prof. H. Le Roy, Rochester, N. Y..... 1879
Fay, H. F., Columbus, Ohio..... 1858
Fenzi, Cav. Sebastiano, Florence, Italy..... 1887
Fink, Albert, Louisville, Ky..... 1890
Fisher, Geo. Jackson, M.D., Sing Sing, N. Y..... 1845
Fittica, Prof. F., University of Marburg, Germany..... 1879
Fletcher, Prof. Lazarus, London, England..... 1885
Ford, Prof. Darius R., Elmira, N. Y..... 1874
Ford, Silas W., Schodack Landing, N. Y..... 1873
Fresenius, Prof. C. R., Wiesbaden, Germany..... 1879
Fritz-Gaertner, Dr. R., Tegucigalpa, Honduras..... 1879

Gadolin, Gen. Alex., St. Petersburg, Russia..... 1868
Gaussoin, E., Baltimore, Md..... 1867
Gibbs, Prof. Wolcott, Cambridge, Mass..... 1840
Gilbert, G. K., Washington, D. C..... 1870
Gill, Dr. Theodore, Washington, D. C..... 1858
Gilman, Pres. D. C., Baltimore, Md..... 1876

ELECTED

Girard, Charles, Paris, France 1852
Goessman, Prof. C. A., Amherst, Mass 1865
Gooch, Prof. F. Austin, New Haven, Conn 1888
Goode, Prof. G. Brown, Washington, D. C 1876
Gordon, Dr. Antonio de, Havana, Cuba 1883
Grattarola, Prof. Giuseppe, Florence, Italy 1883
Green, S. F., Jaffna, Ceylon 1867
Greenleaf, R. C., Boston, Mass 1868
Gregg, Dr. Wm. H., Elmira, N. Y 1865
Gregorio, Marchese Antonio di, Palermo, Sicily 1883
Grierson, T. M. D., Dumfriesshire, Scotland 1865
Grote, Prof. Aug. R., Buffalo, N. Y 1876
Groth, Prof. Paul, University of Strassburg, Germany 1877
Gudeman, Dr. Edward, Philadelphia, Pa 1890
Gunning, Thos. B 1878
Guppy, R. J. L., Trinidad, W. I 1869

Hagen, Dr. Herman A., Cambridge, Mass 1874
Hague, James D., New York, N. Y 1874
Hamlin, Chas. E., Cambridge, Mass 1865
Hancock, D., Demerara, W. I 1824
Hanley, Sylvanus, London, England 1864
Hardin, M. B., Lexington, Va 1866
Hartman, W. D., M.D., West Chester, Pa 1852
Hawkins, B. Waterhouse, London, England 1868
Hayes, S. Dana, Boston, Mass 1876
Henry, Charlton F., U.S.A 1853
Henwood, W. Jory, Cornwall, England 1842
Hepburn, J. M., M.D., Japan 1859
Hesse-Wartegg, Count Ernst von, New York 1882
Hexamer, Dr. F. M., New Rochelle, N. Y 1857
Hickock, W. C., Vermont 1848
Hidden, Wm. Earl, Newark, N. J 1875
Hill, Prof. Henry B., Cambridge, Mass 1876
Himes, Prof. Charles F., Carlisle, Pa 1876
Hitchcock, Prof. Charles H., Hanover, N. H 1867
Horsford, Prof. E. N., Cambridge, Mass 1876
Horton, Letas R., Goshen, N. Y 1864
Hoskold, Prof. H. D., Buenos Ayres, South America 1890
Howard, Thos. T., Jr., Perth Amboy, N. J 1877

ELECTED

Hunt, Dr. T. Sterry, Boston, Mass..... 1867
Hyatt, Prof. Alpheus, Cambridge, Mass..... 1876
Hyatt, Prof. James, Stanfordville, N. Y..... 1876

Iles, Malvern W., Denver, Col..... 1875

James, Major O. C., Rio Janeiro, Brazil 1867
Jamieson, Rev. J. M., Sabatha, India..... 1847
Jannetaz, Prof. A., College Sorbonne, Paris, France..... 1883
Jesup, Rev. Henry Griswold, Hanover, N. H..... 1885
Johnson, Prof. Sam'l W., New Haven, Conn..... 1876
Jordan, Pres. David S., Bloomington, Ind..... 1876
Judd, Orange, Middletown, Conn..... 1876

Kellicott, D. S., Buffalo, N. Y..... 1886
Kendrick, Prof. H. L., U.S.M.A., West Point, N. Y..... 1876
Kinney, Prof. J. R., Honolulu, Sandwich Islands..... 1867
Knowlton, W. J., Boston, Mass..... ... 1880
Koenig, Prof. George A., Philadelphia, Pa..... 1876
Koltzoff-Massalsky, Princesse Hélène, Florence, Italy..... 1887
Koschkull, H. von, Tiflis, Caucasus..... 1868
Krebs, H. J., Copenhagen, Denmark..... 1867
Krontschoff, Baron K. de, St. Petersburg, Russia..... 1890
Kuki, R., Tokio, Japan..... 1888
Kulibin, Prof. N., St. Petersburg, Russia..... 1890
Kulibin, Prof. S., St. Petersburg, Russia..... 1890

Lacerda, Antonio de, Bahia, Brazil..... 1867
Lacroix, Alfred, Paris, France..... 1890
Land, Wm. J., Atlanta, Ga..... 1877
Langley, Prof. J. W., Ann Arbor, Mich..... 1876
Lattimore, Prof. S. A., Rochester, N. Y..... 1876
Lauderdale, J. V., M.D., U.S.A..... 1867
Laussedat, Col., Paris, France..... 1890
Lea, M. Carey, Philadelphia, Pa..... 1876
Le Conte, Prof. Joseph, Berkeley, Cal..... 1876
Le Jolis, Dr. Auguste, Cherbourg, France..... .. 1876
Le Mercier, Dr. F. G., Paris, France..... 1869
Lintner, Prof. J. A., Albany, N. Y..... 1872
Lockwood, Rev. Samuel, Freehold, N. J..... 1865
Lord, Henry B., Ithaca, N. Y..... 1868

ELECTED

Lowe, Edward J., Nottingham, England 1857
Lupton, Prof. N. T., Nashville, Tenn 1876

Mackie, Simon F., Salt Lake City, Utah 1869
Macloskie, Prof. George, Princeton, N. J 1876
Mallet, Prof. John W., University of Virginia, Va 1876
Marcy, Prof. Oliver, N. W. University, Evanston, Ill 1871
Marsh, Prof. O. C., New Haven, Conn 1867
Mason, Rev. Francis, Tavoy, Burmah 1844
Matthew, Prof. George F., St. John, N. B 1867
Maynard, C. J., Boston, Mass 1874
McChesney, Prof. J. H., Chicago, Ill 1863
McCormick, Richard H., Arizona 1869
McMurtrie, W. C., M.D., Washington, D. C 1876
Mead, Theodore L., Eustis, Florida 1874
Meek, Prof. Seth E., Cedar Rapids, Iowa 1888
Meneghini, Prof. G., Pisa, Italy 1888
Merriam, Prof. C. Hart, Washington, D. C 1874
Merrick, Prof. J. M., Boston, Mass 1876
Metcalfe, William, London, England 1842
Meyer, Dr. A. B., Dresden, Germany 1890
Michie, Prof. P. S., West Point, N. Y 1885
Minot, Dr. Charles S., Boston, Mass 1878
Mixter, Prof. Wm. G., New Haven, Conn 1876
Moldenke, Richard G. G., Houghton, Mich 1890
Moore, Whitby E., Para, Brazil 1844
Morch, Otto, Copenhagen, Denmark 1864
Morong, Rev. Thomas, Ashland, Mass 1888
Morse, Prof. Edward S., Salem, Mass 1864
Mortimer, Capt. John H., New York 1875

Nason, Prof. Henry B., Troy, N. Y 1876
Netto, Prof. Ladislau, Rio Janeiro, Brazil 1890
Nevius, Rev. Reuben D., Baker City, Oregon 1867
Newcombe, Wesley, M.D., Ithaca, N. Y 1835
Newton, Prof. Alfred, Cambridge, England 1866
Nicholls, Dr. H. A. Alford, Dominica, W. I 1882
Nicolis, Sig. Cav. Enrico, Verona, Italy 1884
Niles, Prof. Wm. H., Boston, Mass 1881
Nolan, Dr. Edward J., Philadelphia, Pa 1880
Nordenskjöld, Prof. N. A. E., Stockholm, Sweden 1868

ELECTED

Ober, Frederick A., Beverly, Mass. 1879
Oothout, Henry, Stamford, Conn. 1865
Ordway, Prof. John M., New Orleans, La. 1876
Orton, Prof. Edward, Columbus, Ohio. 1871
Ostensacken, Baron R., St. Petersburg, Russia. 1857

Packard, Prof. A. S., Jr., Providence, R. I. 1866
Packard, R. L., Washington, D. C. 1877
Paine, Prof. John A., Tarrytown, N. Y. 1877
Palmer, F. Temple, Versailles, France. 1836
Parrott, Rev. Dr. J. W., Addison, Steuben County, N. Y. . . . 1869
Pecchioli, V., Pisa, Italy. 1846
Peck, Thomas M., Grand Rapids, Mich. 1853
Peckham, Prof. S. F., Bristol, R. I. 1876
Perkins, Prof. Maurice F., Schenectady, N. Y. 1876
Phené, Dr. J. S., London, England. 1882
Pickering, Prof. Ed. C., Cambridge, Mass. 1876
Piddington, Henry, Calcutta, India. 1846
Pisani, F., 8 Rue Furstenburg, Paris, France. 1883
Poey, Prof. Andreas, Paris, France. 1869
Post, Prof. George E., Beirut, Syria. 1888
Potter, Prof. W. B., Washington University, St. Louis, Mo. . 1871
Prescott, Prof. Albert B., Ann Arbor, Mich. 1876
Prime, Prof. Frederick, Jr., Easton, Pa. 1877
Pumpelly, Prof. Raphael, Newport, R. I. 1868
Purdie, H. A., Boston, Mass. 1874
Putnam, Prof. F. W., Cambridge, Mass. 1860
Pynchon, Prof. Th. R., Hartford, Conn. 1876

Ramsey, J. G., M.D., Tennessee. 1860
Randall, F. A., Warren, Pa. 1876
Rawson, Sir Rawson W., London, England. 1867
Read, Matthew C., Hudson, Ohio. 1876
Reade, T. Mellard, C.E., Liverpool, England. 1888
Redfield, John H., Philadelphia, Pa. 1836
Remsen, Prof. Ira, Baltimore, Md. 1876
Ridgway, Robert, Washington, D. C. 1874
Robb, Prof. Wm. Lispenard, Hartford, Conn. 1886
Robertson, J., Atticus, N. Y. 1864
Roemer, Charles F., Berlin, Prussia. 1845
Roemer, Edward, M.D., Cassel, Germany. 1864

ELECTED

Rogers, F. M., Luling P. O., Louisiana 1877
Rogers, Dr. Henry R., Dunkirk, N. Y 1882
Rosa, W. V. V., M.D., Watertown, N. Y 1866
Russell, Israel C., Washington, D. C 1879

Sadtler, Prof. Samuel P., Philadelphia, Pa 1876
Salvadori, T., M.D., Turin, Italy 1866
Saussure, H. de, Geneva, Switzerland 1856
Schaeffer, Prof. C. A., Ithaca, N. Y 1876
Schweitzer, Dr. Paul, University of Missouri, Columbia, Mo.. 1867
Sclater, Philip L., London, England 1856
Scudder, Prof. Samuel H., Cambridge, Mass 1876
Sherwood, Andrew, Mansfield, Pa 1876
Sinclair, William, West Hoboken, N. J 1847
Skinner, Ezekiel, M.D., Liberia 1837
Slosson, Charles, Buffalo, N. Y 1885
Smith, Charles E., Philadelphia, Pa 1866
Smith, J Bryant, Kingston, Jamaica, W. I 1852
Smith, J. Ward, Newark, N. J 1883
Smith, Sanderson, Staten Island, N. Y 1854
Smith, T. L., M.D., U.S.N 1849
Sorby, Henry C., Sheffield, England 1858
Spang, Norman, Etna, Alleghany County, Pa 1876
Spencer, Rev. J. Selden, Tarrytown, N. Y 1890
Stearns, Robert E. C., Berkeley, Cal 1876
Stevens, Dr. Robert P., Brooklyn, N. Y 1875
Stillman, Charles H., M.D., Plainfield, N. J 1840
Stillman, J. B., M.D., Texas 1855
Stoebner, Prof. F. W., Westfield, Mass 1882
Storer, Prof. F. H., Jamaica Plain, Mass 1876
Stout, A. A., M.D., U.S.N 1847
Stretch, Richard H., San Francisco, Cal 1865
Stuart, A. P. S., Lincoln, Neb 1876

Taber, Augustus, Westchester County, N. Y 1854
Tajore, The Maharajah Sowindho Mokun, Calcutta, India 1885
Taylor, Alexander S., California 1860
Thomson, James, Paris, France 1845
Thurston, Sir John, Gov.-General Fiji Islands 1887
Thurston, Prof. Robert H., Ithaca, N. Y 1876
Thwing, Rev. Edward P., Brooklyn, N. Y 1885

ELECTED

Torrey, H. Gray, Stirling, N. J. 1866
Trowbridge, Prof. John, Cambridge, Mass. 1877
Tryon, A. W., Philadelphia, Pa 1873
Tryon, G. W., Jr., Philadelphia, Pa 1864
Tuttle, Prof. D. K., Baltimore, Md 1876

Van Heurck, Henri, Antwerp, Belgium 1871
Verrill, Prof. A. E., New Haven, Conn 1867
Villa, Antonio, Milan, Italy 1846
Villa, J. B., Milan, Italy 1846
Vogdes, Capt. A. W., Fort Canby, Wash 1890
Volhard, Prof. Jakob, University of Munich, Germany 1879
Vollum, Dr. Edw. P., Jefferson Barracks, Mo 1880
Voss, Lothair, Berliburg, Prussia 1869
Waldo, Leonard, Bridgeport, Conn 1876
Ward, James W., Buffalo, N. Y 1876
Ward, Prof. Henry A., Rochester, N. Y 1888
Warren, Rev. Joseph, Allahabad, India 1848
Warring, Prof. Charles B., Poughkeepsie, N. Y 1876
Webber, Thomas, Kelleyville, Ireland 1887
Weissbach, Prof. A., Berg Akademie, Freiberg, Saxony 1883
Wheatland, Henry, M.D., Salem, Mass 1858
White, Rev. G. W., Marietta, Ohio 1854
White, Prof. I. C., Morgantown, W. Va 1874
Williams, Prof. J. Francis, Worcester, Mass 1890
Winchell, Prof. N. H., Minneapolis, Minn 1878
Wissman, J. F., San Francisco, Cal 1869
Wood, Horatio C., M.D., Philadelphia, Pa 1866
Woodward, Henry, London, England 1868
Wormley, Dr. Theodore G., Philadelphia, Pa 1875
Wright, Prof. Albert A., Oberlin, Ohio 1874
Wright, Prof. Arthur W., New Haven, Conn 1876
Wynne, James, M.D., Central America 1857

Yarrow, Dr. H. C., Washington, D. C 1876

HONORARY MEMBERS.

(RESTRICTED TO FIFTY.)

	ELECTED
Agassiz, Prof. Alexander, Cambridge, Mass	1887
Akerman, Prof. A. R., Stockholm, Sweden	1876
Barroit, Mr. Charles, Lille, France	1889
Bunsen, Prof. Robert, Heidelberg, Baden	1876
Candolle, Prof. Alph. de, Geneva, Switzerland	1852
Croll, Prof. James, Edinburgh, Scotland	1876
Dallinger, Rev. J. H., London, England	1887
Dana, Prof. James D., New Haven, Conn	1842
Dawkins, Prof. W. Boyd, Manchester, England	1876
Dawson, Sir William, Montreal, Canada	1876
Descloizeaux, Prof. A., Paris, France	1876
Fizeau, Armand H. L., Paris, France	1879
Flower, Prof. W. H., London, England	1887
Frankland, Prof. Edward, London, England	1879
Geikie, Prof. Archibald, London, England	1876
Geinitz, Prof. Hans Bruno, Dresden, Saxony	1876
Gibbs, Dr. Wolcott, Newport, R. I	1889
Goodale, Prof. Geo. L., Cambridge, Mass	1889
Hall, Prof. Asaph, Washington, D. C	1889
Hall, Prof. James, Albany, N. Y	1852
Hartlaub, Dr. Carl T., Bremen, Germany	1864
Hauer, Prof. Franz Ritter von, Vienna, Austria	1864
Helmholtz, Prof. H., Berlin, Prussia	1876
Hofmann, Prof. A. W., Berlin, Prussia	1876
Hooker, Sir Joseph D., London, England	1879
Hunt, Prof. T. Sterry, New York, N. Y	1891
Huxley, Prof. Thos. H., London, England	1876
Kenngott, Prof. Adolph, Zurich, Switzerland	1864
Kokscharow, Prof. Nicholas von, St. Petersburg, Russia	1879

	ELECTED
Lange, Prof. Victor von, Vienna, Austria	1876
Langley, Prof. S. P., Washington, D. C	1887
Lockyer, Mr. J. Norman, London, England	1880
Mueller, Baron Ferd. von, Melbourne, Australia	1887
Newcomb, Prof. Simon, Washington, D. C	1891
Owen, Prof. Richard, British Museum, London, England	1879
Pasteur, Prof. Louis, Paris, France	1887
Quatrefages, Prof. J. L. A., Paris, France	1879
Rawlinson, Sir Henry Cresswicke, London, England	1882
Richter, Prof. Th., Freiberg, Saxony	1876
Roscoe, Sir Henry, Manchester, England	1887
Rosenbusch, Prof. H. F., Heidelberg, Germany	1887
Stokes, Sir Geo. G., London, England	1889
Szabò, Prof. Josef, Buda-Pesth, Hungary	1890
Thomson, Sir William, London, England	1876
Torell, Prof. Otto, Stockholm, Sweden	1876
Tunner, Prof. P. Ritter von, Leoben, Austria	1876
Tyndall, Prof. John, London, England	1887
Young, Prof. Charles A., Princeton, N. J	1878

VOL. X. OCTOBER. No. 1.

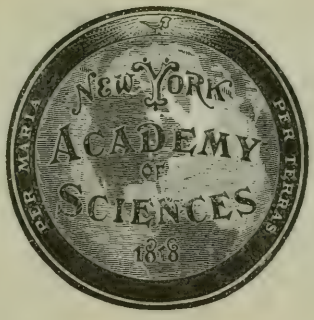
S422.

TRANSACTIONS

OF THE

NEW YORK ACADEMY OF SCIENCES

1890-1891.



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TRANSACTIONS

OF THE

NEW YORK ACADEMY OF SCIENCES.

October 6th, 1890.

REGULAR BUSINESS MEETING.

The President, DR. NEWBERRY, in the chair.

In consequence of the very inclement weather, the attendance was somewhat limited, only fifteen persons being present.

The minutes of the previous meeting (June 9th) were read and approved.

The report of the COUNCIL (October 2d) was read, recommending:

I. The payment of the following bills:

Publication of the ANNALS, Vol. V., Nos. 7 and 8	$180.21
Publication of the TRANSACTIONS, Vol. IX., Nos. 6, 7, and 8	203.49
Minor expenses	29.42

II. Price of single numbers of the TRANSACTIONS to non-members shall be fifty cents, extra copies to members twenty-five cents each. Authors will be allowed 25 copies of separates free, if desired. Back numbers of the current volume will be furnished at half price to members joining during the sessional

year. Authors making considerable alterations in the proof of their papers, will be charged current rates.

III. The appropriation of the following sums of money:

For binding books in Library	$100.00
For salary of Assistant Recording Secretary	100.00
For office expenses of Recording Secretary	25.00

IV. The election as Resident Members of

DR. DAVID E. BARRY,
OSBORN R. LAMB.

Mr. Lamb has since become a Life Member.

In consequence of removal from New York City to the Pacific coast, CAPTAIN A. W. VOGDES presented his resignation as Librarian in a letter, which was accepted with regret. DR. JOHN I. NORTHROP was nominated and unanimously elected to the vacancy, and received the trust in a few well-chosen words. CAPT. VOGDES and DR. MEADE BOLTON were transferred to the list of Corresponding Members.

The following name was placed in nomination as Corresponding Member by the Recording Secretary:

PROFESSOR W. D. ALEXANDER,
of Honolulu, Hawaiian Islands.

The following paper was read by title:

COLEOPTEROLOGICAL NOTICES, NO. 2.
BY THOMAS L. CASEY.

PRESIDENT NEWBERRY then announced that, in conformity with custom and the notices for the evening, the members present were invited to speak of the places or objects of interest visited or seen during the summer vacation. Responses were made as follows:

MR. L. H. JACOBY said that he had lately returned from South Africa, having been a member of the U. S. Eclipse Expedition; that astronomically the expedition had been a failure, on account of cloudy weather; but that later in the season he

would give the Academy an account of some subjects of interest connected with the expedition.

Dr. Northrop stated that he had returned from the Bahama Islands during the summer, where he had spent several months studying their geological features, and had made collections of their flora and fauna of considerable interest. In a short time he intended reading a paper before the Academy, giving the results of his studies in this interesting group of islands. Incidentally Dr. Northrop remarked that he had lately seen a turkey buzzard at Cornwall-on-the-Hudson, N. Y., and stated that this bird is rarely, if ever, seen so far North.

Dr. Bolton, who had lately returned from a trip to the Hawaiian Islands and California, after an absence of nearly seven months, stated that he had been remarkably successful in his search for sonorous sand, and had enjoyed a very pleasant trip, going and coming. He gave a brief description of the places visited, and excused his brevity on the score of presenting details to the Academy during the coming winter.

Dr. Newberry said that the summer had been a busy one. Early in the vacation he made a visit to Silver Cliff, Colorado, on his return finishing his Monographs on the Laramie Flora and the Amboy Clays. He had also studied the flora of the coal basin of the Great Falls of the Missouri. At first no fossils were found ; finally, in a railroad cut in the vicinity, remains of ferns and conifers were discovered; these belong to the Potomac Group of the Lower Cretaceous.

Dr. Britton said that he had been closely engaged in botanical work, but found leisure to visit Indianapolis, being present at the meeting of the American Association for the Advancement of Science, where he had a very pleasant time.

October 13th, 1890.

STATED MEETING.

The President, DR. NEWBERRY, in the chair.

About twenty-five persons present.

The minutes of October 6th were read and approved.

The following paper was read by title :

CONTRIBUTIONS TO INVERTEBRATE PALÆONTOLOGY.

BY PROF. R. P. WHITFIELD.

MR. L. H. JACOBY exhibited two fine specimens of crocidolite from the Orange Free State, Africa, one in the rough, the other a polished sphere. The exhibitor said that he had purchased the specimens, and could not give the locality from which they came. DR. NEWBERRY explained the composition and physical character of the mineral, and stated that nothing was known of the existing deposits.

The following paper was then read by DR. JOHN I. NORTHROP :

NOTES ON THE GEOLOGY OF THE BAHAMAS.

(Abstract.)

By far the greater number of the islands known as the Bahamas, are situated on the Great and the Little Bahama Banks. The former occupies a large area southeast of Florida and north of Cuba, and is penetrated in the northern part in a remarkable manner by a tongue of the ocean in which the water is over seven hundred fathoms in depth. Little Bahama Bank lies north of the Great one and is much smaller.

The islands lie, almost without exception, on the northern and eastern edges of the banks, the main exception being the island of Great Bahama, which is situated on the southern edge of Little Bahama Bank. Southeast of the Great Bank is a small one, on which are Crooked and Acklin islands, the former on the northern, the latter on the eastern edge.

The Caicos Bank lies still farther southeast and contains on its northern border a number of small islands. The rest of the

group—viz., the islands of San Salvador, Rum Cay, Atwood's Cay, Mariguana, and Little and Great Inagua—are differently situated from those previously mentioned, rising almost abruptly from the deep ocean.

The time spent in the Bahamas was a little more than six months, two of which were passed in New Providence and the rest in Andros. The former is well known as the seat of government and as a health resort. It lies on the northern edge of a portion of the Great Bahama Bank, and is about twenty miles long and seven in width. A ridge runs along the northern side, the highest point of which is 109 feet above sea-level, and is occupied by an old fort—Fort Fincastle. Here a fine view of the general features of the island may be obtained. To the south stretches a low, level country dotted here and there with cocoanut groves, and in the distance is seen a lower ridge, known as the Blue Hills. To the north we look over the harbor, half a mile in width, to Hog Island, a cay about four miles long, perhaps half a mile wide, and about twenty feet high. The eastern end is separated by a narrow piece of water, known as the "Sea Garden," from Athol or Long Island, locally known as Quarantine Station, a cay about two miles long and but a quarter-mile wide, and continued eastward by narrow shoals. West of Hog Island is the channel, or, as it is called, "the bar," on the other side of which a number of small cays continue the same general direction as the longer axis of the island. Seaward of Hog Island, and separated from it by about one mile of water, is Salt Cay, an island about two miles in length and a quarter in width. Farther to the north and outside of Quarantine Station is Rose Island, another long, narrow cay. Outside of all lies the reef. These facts have been given with perhaps more detail than is interesting, but which, nevertheless, is necessary, as it has a bearing upon what follows.

Andros Island is the largest of the Bahama group, being over ninety miles long and between forty and fifty miles wide. The northern portion is separated from the southern by a broad, shallow sheet of water that contains many cays, large and small, and the passages through from the eastern to the western coast are known as bights. It is interesting to note that Andros is not only the largest of the Bahama islands, but the largest coral island in the world, its northern half alone having a superficial area of over 1,200 square miles, while the area of the whole island, so-called, is over 1,900. It lies near the eastern edge of the bank that faces the tongue of ocean referred to above.

The eastern side of Andros is occupied by a ridge, of which the highest point that I visited, and I think the highest on the

island, is marked on the chart as Salvador Point, locally known as Bearing Point. Its height I had no means of determining, but I judged it to be about 100 feet. At the extreme southern end, as at Grassy Creek, this ridge is absent and the land is low.

When one has crossed the ridge, which is covered with angiospermous trees, he enters a large forest of *Pinus bahamensis* which occupies the greater portion of the interior of the island. The land is here almost level, and in some places, as near Loggerhead Creek and Wide Opening, there are extensive lakes of fresh water. Upon passing through the pines and reaching the west side, one comes to the most remarkable feature, however, of the island. Here one sees spread out before him, as far as the eye can reach, a low, swampy country covered with small mangroves, *Conocarpus* and *Avicennia*, bounded on one side by the water, and sometimes, in the distance, by a dark line of pines. The pines, however, frequently jut out in points that approach quite close to the water's edge. This level, swampy land is locally known by the very appropriate name of "swash." To the west of the land stretches the Great Bahama Bank for a distance of from fifty to seventy miles, and the slope of the bottom is so exceedingly slight that at the distance of seventy miles from shore the water is but three or four fathoms deep. The bank then plunges suddenly into the ocean beyond.

There are many creeks on the island, and the water in all, at a distance of ten or fifteen miles from the mouth, is drinkable. Many little streams of fresh water flow into these creeks, thus partially draining the immense area of swash.

The creeks are generally narrow and winding, and by wearing away the land on the convex side of the curves change the character of the surface of the country. This was most plainly seen up Cabbage Creek, near Wide Opening, on the west side. Here, as the creek wore its way into the land, it was followed on the concave side by a growth of small mangroves, while its convex side was fringed with palmettos. As the creek, in winding, changed its course, the palmettos and mangroves changed sides, as it were, the former always on the outside of the curve, thus making quite a striking alteration in the appearance of the landscape.

The surface on the western side of Andros is composed of an exceedingly fine, almost impalpable calcareous coral "mud" that also forms the bottom of the shallow water that covers the bank. As we go back from the water's edge this deposit becomes harder and harder, until finally it is cemented into a hard, very fine-grained rock that is very different in appearance

from the rock of the eastern coast. The latter is Æolian and varies in texture. In some places it is quite coarse and in others fine, but always composed of rounded grains of coral sand or comminuted shells. In some places, as at Conch Rock, near Conch Sound, the rock has been so altered as to resemble a dark-gray crystalline limestone. In one place only did I see the contact between the Æolian formation and the true coal rock. This was on Andros near the entrance to Fresh Creek, where a vertical face about ten feet in height was exposed. The lower four feet were composed of fragments of coral stems, mostly a madrepore, probably *M. cervicornus*, but so eroded as to make identification impossible. Above this lay the Æolian rock, the contact being sharp and distinct, and the contrast between the laminated appearance of the one and the irregular surface of the other being very striking. While no masses of corals were to be seen, that were undoubtedly standing as they grew, the fragments, some of them about a foot in length, were crowded together and presented the same appearance as I had seen in places in the reef at Nicols Town, where the branches of *M. cervicornus* had been broken off and lay in a heap on the bottom. The striking contrast between the Æolian rock above and that in which the corals were, showed plainly that the two rocks were formed under different circumstances, and that the lower stratum had been formed under water, for it showed none of the characteristics of beach or wind-drifted deposits. Although this is the only place where elevated corals were found in profusion, in many other localities, as at Nicols Town and Mastic Point, Andros, a few fossil corals were found embedded in the rock and evidently in place. The most common coral thus found was a Mæandrina, probably the same as now living on the shore near low-water mark—a circular, flat species.

In Nassau excellent sections of the rock can be seen in an old quarry, the "Queen's Staircase," and in the present quarry. In the first of these places the section is, I believe, ninety feet high, and the rock is entirely Æolian. The most common fossil is a species of Strophia that I suspect will prove different from those now living on the island.[1] A few helicoid shells were collected, and parts of a crab were noted, but only one or two marine shells, a Fissurella, and fragments of a lamellibranch were obtained. These facts all indicate the Æolian origin of the deposit.

[1] My thanks are due to Prof. Dall, who has kindly examined my Strophias, and who is inclined to provisionally refer some of the fossil forms to *S. maritima* Pfr., and states that others seem to connect *maritima* with forms like *Glans* Kust. which I found living on Andros.

Surface Deposits.

There is practically no soil either on New Providence or Andros, except the little that collects in the caves and holes in the rock. From the caves a large quantity of cave earth has been taken and sold as a fertilizer, with what result I do not know. I was told that guano had been found on Andros, but I saw none. The earths I collected I have treated with hydrochloric acid, and the results indicate a great variation in composition. In some, most of the material is soluble with strong effervescence, but in others the residual, I suspect, will prove greater than the soluble portion. The residue seems to be composed of organic material, with some mineral constituents that contain an appreciable quantity of iron. Dr. Waller, of the School of Mines, Columbia College, has kindly offered to analyze my material, and we hope from the results to draw some conclusions as to its origin. At present it seems as if the earthy deposits are composed of the insoluble portions of the coal rock mixed with vegetable particles.

The absence of any large quantity of fallen leaves is very noticeable. In the "Pine Yard," as the pine woods are locally called, we did not see a single fallen pine, but the depressions in the ground showed where one had formerly stood, and a long, shallow trough plainly indicated where the fallen trunk had lain. Desiccation and decay take place with astonishing rapidity, and I believe that the deposits found in the caves are greatly added to by the comminuted particles of dried vegetable matter, and the residue of the decomposed portions, both of which would be washed in by rain-water.

On the "swash" on the west coast of Andros a peculiar ash-like deposit was noticed that covered small circular areas. This on examination proved to be composed of soft, elastic lumps coated with calcareous material. These lumps under the microscope were seen to be composed of one of the small, probably fresh-water, algæ that had grown in the pools of water, and which had been left when the pools had dried.

Erosion.

One of the most striking geological changes taking place in the Bahamas is the erosion of both the surface and the shore line of the islands.

West of Nassau, on the beach, are many places where the waves have cut narrow passages into the rocks and ground the fragments into sand. There are also a number of "pot-holes": these were circular in horizontal sections, and the bottom and

sides were smooth. They contained the worm coral heads that had evidently been the means of making the holes.

On the beach of the cays north of Nassau great blocks of coral rock are seen that have been dislodged by the waves, and in some places fresh fractures show where large fragments have been broken off. On the south side of the cays the erosion is different. Here the water is quiet and eats slowly under the rock, so that a projecting ledge is formed that marks the height of the tide.

At some places on Andros, as at Fresh Creek and Nicols Town, the shore is undermined, and great slabs in places have fallen, thus making large cracks. Similar cracks are found inland higher above high-water mark, and have evidently been formed in the same manner as those on the shore. Where the edges of the crack were in contact they had been firmly cemented together, and at intervals along the line of the crack were numerous large holes that had evidently been worn out by the action of rain-water running over the edge. Leading into these holes were channels almost as perfectly formed and rounded as a tin gutter.

The erosion of the surface will impress every one that visits the Bahamas. Sharp, jagged points project so as to make walking tiresome and annoying. Although there is some sand near the beach west of the Barracks at Nassau, there are no great moving masses such as Heilprin describes as being found in Bermuda.[1]

In some places, as on Goat Cay, near Fresh Creek, Andros, the surface is eroded in a peculiar and striking manner. There the rock is worn so as to leave *vertical* cylindrical masses two or three feet high, some connected below or half-way up with each other, others separate. Their sides and tops are pitted and eroded, so they have evidently been affected by atmospheric agencies. On the ocean side of this cay the erosion from the action of the surf was so exceedingly rapid, that the rock remained a light yellowish color instead of the dull or dark gray it commonly assumes. The form the rock here presented was even more striking than the cylindrical masses described above. It was worn into innumerable peaks and pinnacles like a miniature mountain range, the points and edges of the pyramidal projections being sharp and clean. As we walked back from the edge of the cay, every gradation could be found between the miniature peaks and the cylindrical masses higher up. And I believe that the latter are what remains after the edges of the little peaks and pyramids have been slowly worn away by the action of atmospheric agencies; for we have only to round off the points

[1] "The Bermuda Islands," p. 31.

and deepen the connecting ridges to produce the vertical cylindrical masses. But in order that this could have occurred, it will be necessary to suppose that the island has been elevated, and this, as I hope to show, I believe has been the case.

Outliers.

In many places near Andros, as at Mastic Point and Golden Cay, there are cays separated from the island by water but a few feet in depth, and in some places these cays make a prolongation of a point with which I believe they were formerly connected, and have been cut off, not by subsidence, but by erosion. There are other cays, as those near Nassau, that, as I hope to be able to show, owe their origin to another source.

Caves.

One of "the sights" at Nassau are "The Caves," about seven miles west of the city. One of these is an irregular opening in the north side of a hill that faces the sea. The floor is considerably above high-water mark. In the back of the first chamber is a small opening through which can be seen a deeper chamber, in the bottom of which is water. This chamber is said to connect with the cave on the opposite side of the same hill. This second cave is a long chamber about fifteen or twenty feet in height, and the roof contains holes through which the roots of trees pass and fasten into the floor below. The side wall of the cave for a distance of about four feet from the ground projected about six inches beyond the upper part of the wall, thus forming a shelf that was quite level and ran the entire length of the chamber, a distance of perhaps one hundred feet. I could only explain the formation of this shelf by supposing that it represented the contact between two deposits, and that the upper had yielded more rapidly than the lower to erosion.

On Andros I saw a number of caves near the northern part of the island. All were in the sides of the elevated portions. The openings in some, as one near Nicols Town, were small, barely as large as an ordinary door. Others were simply excavations in the side of the hills.

In some places, as near Nicols Town and Mastic Point, small caves were found, twenty to forty feet above high-water mark; and the low, vertical cliffs in which they were, indicated the existence of an old shore line, for the rocks were undermined in the same manner as those we now see on the present shore.

In some of these caves Indian relics have been found, and also human bones, and I obtained a portion of a human humerus from one on Andros.

Ocean-Holes.

Near the caves at Nicols Town was a hole known as the "Ocean-Hole." It was about one hundred feet in diameter and perhaps forty feet in depth, and contained a pool of brackish water. In one place the wall had been excavated so as to form a small cave, while the rest was quite steep and covered with trees and large blocks of coral rock. In one place was a very marked unconformability in the rock, the seeming strata below lying at an angle of about thirty degrees, while above the layers were horizontal. This was probably only an unusual arrangement of the Æolian formation; but in the Queen's Staircase, where an unusually fine section is exposed, the layers lie at different angles, but are wedged in between each other, as it were, and no such sharp unconformability as that above described is to be seen.

The name "ocean-hole" is also applied by the natives of Andros to deep holes *under* the water. Some of these are remarkable. The first that I saw was near Mangrove Cay. Here, close to the shore, was a nearly circular hole at least 100 feet in diameter, and in which the water was said to be over 18 fathoms (104 feet) in depth. I did not have an opportunity of sounding it, but the dark blue color of the water told its own story.

While sailing up Fresh Creek, Andros, we came to another ocean-hole, which I examined. It was about ten miles from the mouth of the creek, close to the northern bank, and about one hundred feet in diameter. From the shore the water for a distance of about fifteen feet was two feet in depth, and then suddenly deepened to eighteen feet over a projecting ledge. Sounding across the hole did not show a greater depth. The bottom of the hole was of soft coral mud. The bottom of the creek surrounding the hole was covered with about two feet of water, and in some places gradually sloped into the hole. Still farther up the creek another hole was seen, but was not examined. The most remarkable ocean-hole that I saw was one near Grassy Creek, near the southern end of the east side of Andros. The diameter was about one hundred and fifty feet, and the shore itself formed one edge of the hole. The sides were of sand at its angle of repose for a depth of about six or seven feet below, and resting on an overhanging ledge of rock. Where the tide had fallen it left the hole surrounded by at least a quarter-mile of sand flat on the ocean side, while, as stated above, the shore formed the rest of the boundary. This hole I sounded with all the line I possessed, but at twenty fathoms the weight was cut off and I was unable to obtain another to continue the

sounding. The captain of our boat, a reliable man, told me that in the "Pine Yard" was a hole similar to this one, in which he had found no bottom with a line over thirty fathoms in length. Before attempting to explain the formation of these ocean-holes it will be well to describe what the natives call

Boiling-Holes.

The first of these I was shown on Andros in a small creek that runs into Conch Sound. The top of the hole was about a foot under water at low tide, and close to the mangroves that formed the side of the creek. It was about seven feet in length and about two or three wide. Below the diameter increased, forming an overhanging ledge. When the tide was low in the creek, but rising outside, the clear sea-water could be distinctly seen ascending, thus producing the same appearance as that presented by a mixture of sulphuric acid and water. Suspended particles could also be seen rising.

While sailing past Rat Cay, near Mastic Point, another "boiling-hole" was seen that was apparently about ten feet in diameter, and from a distance we could see a perceptible "boil" on the surface that was undoubtedly caused by the rising water. Our captain said that when the tide was falling the water in the hole went "down and round"—which statement I believe, as the water was rising with some force, and probably ran out again with sufficient rapidity to cause a small whirlpool. In another boiling-hole near Mangrove Cay the water was seen ascending.

These facts prove not only that an underground connection exists between these holes and the ocean, but that the connection is an open one, so that the water can flow freely through it, and thus the pressure resulting from the passing tidal wave is shown before the tide commences to rise on the shore. The ocean-holes, I believe, can be explained by supposing them to be old boiling-holes in which the connection has been stopped up, and their greater size caused by the falling-in of the ledge on the edge, which would aid in the stoppage. I regret that I have no facts to offer on the depth of the boiling-holes, for the only one I stopped to examine was at Conch Sound, and this one ran under the ledge, so that its depth could not be determined. The ocean-hole at Nicols Town, described above, is also, I believe, an old ocean-hole now elevated.

Banana-Holes.

These are holes found mainly on the elevated parts of the land on both New Providence and Andros. They contain a quantity

of earth in the bottom, in which the natives plant their bananas, and hence the name.

In shape and dimensions these holes vary greatly. Some are cylindrical, about four feet in diameter, but at the same time twenty feet or more in depth. Others are from ten to twenty-five feet across, and some even larger, and often of an irregular shape and much longer than wide.

The walls are often excavated below, so that the side becomes an overhanging ledge and forms a small cave. In some a cave begins at the side of the hole and runs backward. It is hence hard to draw the line between these holes and the caves. There are also holes that are not called banana-holes, but which may be here described, as they differ only in shape. In some the opening is barely large enough to allow a man to pass. One such I descended, and found that below it was over five feet in diameter and cylindrical. The top had been excavated so as to form a domed roof.

Other holes were connected by a horizontal passage through which I could crawl from one to the other. One of these I saw near Conch Sound, where the passage ran from the bottom of one hole to the side of the other, which was much deeper.

Near by I saw two shallow holes that were connected by a horizontal passage, so that they resembled a large tube bent up at each end. It is not unusual to find openings in the ground, barely large enough to admit an ordinary pail, and sometimes much smaller. These are simply openings in the roof of a cave or hole of unknown dimensions, and frequently in the bottom is a quantity of fresh water that is used by the people.

The subject of banana-holes has been briefly discussed by Dr. C. S. Dolley,[1] who accounts for their formation by "the action of decaying vegetable matter, that undergoes fermentative changes by the products of which the soft, calcareous rock is dissolved and leaches away." There is no doubt that the rock is in many places eroded in this manner, as the small, saucer-shaped depressions so common on the surface, and each often containing leaves and water, plainly testify. But I doubt if this agent alone would cause the deep vertical cylindrical holes, or those in which the sides recede into caves or the horizontal passages. And if the holes were formed in the manner described by Dr. Dolley, should we not find them in the low level land as well as on the ridges? But, as stated before, the holes are found in far greater number on the ridges, and in places where the surface is such as to indicate that formerly the erosion from the waves was

[1] Proc. Acad. Nat. Sci., Phila., 1889, p. 132.

very great. If we could have a good view of the proper bottom of a banana-hole, we might be able to account for their formation; but, unfortunately, the bottom is always filled with a deposit of earth or blocks of coral rock, and generally covered with vegetation.

It is not improbable that the deep cylindrical ones were formed in the same manner as pot-holes. And others might have originated in the same way as the spouting-holes, where the waves undermine the shore and afterward break an opening in the rock above. Should some of the boiling-holes, described above, become elevated and their bottoms filled up with fallen blocks of coral rock and deposits of earth, they would form banana-holes. The holes in the cracks at Fresh Creek can be easily explained, but if all banana-holes were formed in this manner we should find them in a line with others, which I was told was the case, but I was never able to satisfy myself that it was so. The caves are often the result of the former action of the sea, and some of them have probably been washed out by rain-water; but in either case, should a portion of the roof fall in, it would make a banana-hole if small, or, if large, an ocean-hole like the one near Nicols Town. The horizontal passages are evidently washed out by water, but whether by the sea or rain-water I do not know, but I believe either might have accomplished it. It is difficult to understand how underground channels could be formed under water, yet the boiling-holes prove that such exist; but there is no means of determining whether they were formed under the present circumstances or at some previous period when the land might have been elevated.

I was told that holes were as common under the water as they were on the land, but did not myself observe this to be the case; but then my opportunities for observation in this direction were limited. I infer from the facts I have given that banana-holes and caves pass gradually into each other, and that they have been formed by the action of the sea-water and afterwards modified by the action of rain-water, aided by the products of the decomposing vegetable material and in some cases by the falling-in of the roofs of the caves.

Effects of Vegetation on the Surface.

One of the facts that I noticed shortly after my arrival in the Bahamas was the occurrence of great numbers of blocks of coral rock scattered irregularly over the ground, and I first thought that they were the result of the excessive erosion that I saw taking place around me. But on some of the cays—as on Goat Cay, described above—where the erosion was most rapid, there

were no loose blocks, and if these had been formed by erosion alone it was there that we should have found them most numerous.

I had often noticed the gnarled and stunted appearance of the bushes and trees that grew near the shore, and where there was evidently a severe struggle between the sea on the one hand and the plants on the other.

At Quarantine Station I was shown a small bush, *Rhacicallis rupestris,* and was told that it was over twenty-two years old, by a man who said he could remember the plant as "long as he could remember anything." I cut away the rock surrounding the bush, and found that its roots proceeded downward a few inches through the solid rock. At the surface the trunk expanded so as to form a projecting mass that rested on the rock. The bush was only about eighteen inches in height and evidently stunted by lack of nourishment. I then pulled up a number of shrubs in the vicinity, and found that their roots ran under the hard crust that formed the surface of the rock. Further observation showed that in many places the crust had been lifted and broken by the growth of the roots, and then trees were noticed with the base of their trunks surrounded by slabs of rocks that leaned against them. Finally, when the rock becomes eroded, the roots of trees penetrate the holes and crevices, and by their growth crack off large fragments that subsequent erosion forms into boulders. And these boulders are found most abundant where the trees are the largest, and hence where the action of their roots is most vigorous. Hence we may infer that these blocks are formed by erosion and the growth of the roots of the shrubs and trees.

While at Nassau I noticed on the shore in some places—as near Dix Point—vertical masses of rock that ran in an irregularly curving or straight line on the surface. The projections were sometimes about one foot high and two to four inches in width, and containing on their upper edge a number of holes, about half an inch in diameter, that were often shallow and sometimes mere pits, but quite regularly distributed in a single line. These little ridges could sometimes be traced for a distance of fifteen or twenty feet, and had evidently been left standing while the surrounding rock had been eroded. For a long time I was unable to explain their formation. Sometimes the ridges intersected and formed small or large triangles, as the case might be. When I visited the south side of New Providence, I saw growing in the water, in the calcareous mud that there forms the bottom, the Black Mangrove or Salt Bush (*Avicennia nitida*), and radiating from it, projecting about five or

six inches above the ground, were small vertical shoots about three or four inches apart and looking very much like the teeth of a very long wooden rake. These shoots, I afterward found, come from the long, sucker-like roots of the *Avicennia* and also of the Buttonwood (*Conocarpus erectus*). Later, on the west side of Andros, I found these plants growing near the water and also higher up on the beach, which here was a very fine calcareous deposit. This deposit had been slightly raised by the growth of the shoots, and higher up on the shore, where in contact with the shoots, it had hardened into rock. This, I believe, explains the ridges described above, for the roots are frequently a foot below the surface, and the action of fresh water following down the shoots, and probably, also, the action of the juices of the plant, have slightly dissolved the calcareous material and then cemented it into a rock harder than the surrounding deposit. The latter, when erosion commences, wears away and leaves the harder ridge standing. The manner in which the ridges are formed, and the holes in the tops of them, all strengthen this conclusion. The triangular spaces enclosed by the ridges are almost identical in appearance with the triangular spaces marked off by the sucker-like roots that cross each other in all directions.

Rhizomorphs.

While visiting the quarry at Nassau my attention was drawn to some cylindrical masses of coral rock that apparently hung root-like over the edges of the quarry and were about four feet in length. They were, however, cemented to the wall. I broke one off, and on examining it found that the particles of which it was composed were arranged in a concentric manner about a central axis. On the way back from the quarry I pulled up a small shrub, and found its roots penetrating the rock, which had been eroded so as to leave cylinders surrounding them. Dr. Dolley[1] has called attention to these cylindrical and tubular forms, and has explained their formation by supposing that they represent the "ramifications of a now exterminated flora," and also that "the juices of the roots, acting on the sand immediately surrounding them, formed a compact layer. Through erosion and subsidence the vegetation was afterward exterminated, the looser particles of drift rock worn away, and the surface left covered by myriads of tubes of all sizes, formerly occupied by plant roots and rootlets." Later, on Spruce Cay, near Nassau, and at many other places, I found a number of these cylindrical projections, some of which contained a small hole in

[1] Loc. cit., p. 131.

the centre, which in others was filled with calcareous material. I believe Dr. Dolley's theory of the formation of these cylindrical and tubular projections is, in the main, the correct one; for I collected specimens with the roots still in them, and the concentric arrangement shown on cross section shows very plainly that the solvent action of the water, following the path of the root, had been from within outward. As these masses are conspicuous and characteristic, I would suggest that they be called *rhizomorphs;* and this name would also cover the tubular masses that have evidently been formed in the same manner, and which I have found in the ferruginous clays of New Jersey and elsewhere. The action of the water in the latter case has been on the iron contained in the clay.

Dr. Dolley is inclined to think that the rhizomorphs were formed while the sand was in a loose state; and while I do not deny that this might be possible, I believe that all that I saw had been formed by the roots penetrating the already hardened rock; and I furthermore found no rhizomorphs being formed by the plants growing in the loose sand.

Dr. Dolley also states[1] that the "small islands exhibiting these peculiar formations" (rhizomorphs) "are indications, therefore, of erosion and subsidence." I admit the erosion; but as the rhizomorphs are found twenty and thirty feet above the sea-level, I think that subsidence has taken no part in their formation.

These rhizomorphs are not to be confounded with the cylindrical masses described on Goat Cay, for the latter were vertical and did not exhibit the concentric arrangement of the particles so plainly shown in the rhizomorphs, which are found at all possible angles. And if we suppose the masses on Goat Cay to be due to the same process that formed the rhizomorphs, we must suppose that the roots that produced them grew vertically downward, which is extremely improbable. It may be well to state that a few rhizomorphs were found on Goat Cay, and the difference between them and the cylindrical masses was very marked.

It might be asked, if these rhizomorphs have been formed in the manner described, why is it that we do not find them everywhere on the islands? And in answer to this objection it may be said that roots of most of the trees spread out over the ground or slightly under the crust, but do not penetrate the rock; and that the roots of the smaller plants are those that have formed the rhizomorphs, and that these latter show only where there is but little vegetation, and where the erosion is active and not helped by the roots of trees breaking up the surface into blocks as described above.

[1] Loc. cit., p. 132.

Evidence of Subsidence and Elevation.

The facts bearing on the question of subsidence and elevation have already been given, but it may be worth while to briefly review them and give my inferences.

The caves and old beaches now above the sea plainly show where the level of the water formerly was. The section at Fresh Creek proves, as do the other cases of elevated corals, that the island has been elevated. As the formation on top of the corals at Fresh Creek is Æolian, it follows that it could have been deposited only above water; and as the caves and old beaches are at least thirty feet above the sea-level and in the Æolian formation, they could not have been formed until the islands had subsided. Hence we are justified in assuming that at some previous time in their history the islands were at about the same level as now. Then followed a period of subsidence of at least thirty feet, during which the caves and old shore lines were formed. After this subsidence the islands were elevated to about their present position. It only remains to sum up the facts that bear on the question of the most recent movement in the Bahamas.

The fact that on the west coast of Andros, where the slope seaward is so exceedingly slight, the soft, calcareous mud grows gradually harder and harder as we go inland, indicates to my mind that the island has been recently rising; for if it were subsiding or had recently subsided, we may suppose that time enough would have elapsed since its elevation to allow the calcareous deposit to harden into rock, and then, as the subsidence took place, the surface at the edge of the water would be hard rock, which would finally probably extend under the water as the latter encroached on the land. The depth, close to the shore, of the fine calcareous deposit also points to elevation, for in it I ran a pole nine feet. How much deeper it was I had no means of determining, owing to the length of the pole. Now, had subsidence been taking place, should we find this depth of calcareous mud close to the shore? It is perhaps possible, and it might be claimed that the greater the subsidence the greater would be the depth of the mud; but by the time that nine feet of sediment had been laid down it is reasonable to suppose that the mud on the shore would have hardened, and then should we not find the water washing against a rocky shore?

As we approach the west side of Andros from the interior the pines grow smaller and smaller, and the forest is often prolonged into points that run out in the swash and are composed of young and vigorous trees. There are also in the swash small

and *slightly* elevated pieces of land barely above the level of the surrounding ground, and on these are growing young pines. These facts show that the pines are advancing as fast as the conditions admit. Now, we may fairly suppose that within *very recent* geological times the atmospheric conditions were practically the same as now, and that the outward growth of the pines is limited by the elevation of the land from the influence of the salt water. Now, had the land once been as high as at present, it is fair to suppose that the pines would have taken possession of the places they now occupy ; and if subsidence was in progress, they would now be being driven back from their vantage ground. And we may also suppose that before the change from elevation to subsidence had taken place, time enough to allow the pines to grow old would have elapsed ; and hence were the island now sinking, or rather had it recently been sinking, we should expect to find on the western shore the pine forest with an array of old and dying trees facing the sea, and it would not be surprising if some dead pines were found standing in the water. None of these appearances are to be found.

The mangroves, too, point to elevation, for I find recorded in my note books instances of mangroves, far above high-water mark, that were apparently dying, but none were seen in situations that indicated that the water was becoming too deep for them, as would probably be the case if the land had been recently sinking.

These facts have perhaps been treated with too much detail; but when I had been only to Nassau, and had seen the active erosion that was taking place, I was inclined to think that the islands were sinking, and was afterwards forced by the facts given above to alter my conclusion. That most of the cays are being worn away and reduced in size is evident. The vegetation is being driven backward, as indicated by the old and gnarled appearance of the bushes and by the rhizomorphs that remain where the plants once grew. But on the west side of Andros the water is so shallow for a long distance seaward that there is practically no erosion of the land by the waves. A little bank of coral sand and foraminifera raised slightly above the level of the swash is the only evidence of the action of the water.

Formation of the Cays North of New Providence.

The position, size, and shape of these larger cays have already been given on page 5.

Before attempting to explain the manner in which I believe they were formed, I will briefly describe the appearance of the

reef at Nicols Town, Andros, and also that at Rose Island, near Nassau.

At Nicols Town the reef was about a quarter of a mile from the shore, and the water varied from ten to eighteen feet in depth. The reef was almost entirely composed of the great *Madrepora palmarum*, with some small patches of *M. cervicornus*. Both of these corals were growing luxuriantly, and their tips were close to the surface of the receding waves. The reef at Rose Island, however, contained very few specimens of *M. palmarum*, but many of *M. cervicornus*, and also large heads of what are popularly known as "brain corals," but which of the genera so designated I am unable to state. The receding waves left the top of the reef bare, and exposed the sea fans and alcyonoid corals that were growing on the top. Toward the shore the reef sloped gradually downward into a bank of sand, or, in other words, the sandy bottom sloped upward to the top of the reef, which thus presented a very different appearance from the one at Nicols Town, where the corals rose from the bottom. These facts show, I think, that the Rose Island reef is an old one, while the Nicols Town reef is in what we may call its prime. A study of the chart of New Providence shows, running along its northern shore, a number of reefs, some of which are marked nearly dry at low water. Now, in order to convert these reefs into land it is only necessary that they should be slightly elevated or that sand should be deposited on top of them. And this, I believe, is the way in which the cays known as Hog Island, Rose Island, Salt Cay, and Quarantine Cay have been formed. In other words, I believe they have been formed in the same manner as L. Agassiz explained the formation of the cays of southeastern Florida. He argues, however, that as the cays nearest the land, and hence those first formed, are no higher than those farther seaward, it follows that during their formation the land was stationary. Prof. Heilprin,[1] on the other hand, has proved that the Florida Peninsula is, or has lately been, rising. I think I have shown that the Bahamas, or at least the islands of New Providence and Andros, have very recently been rising; and yet, although I have no measurements, I venture to state that Salt Cay, the most seaward one, is as high if not higher than Hog Island, that lies inside of it.

To return to Florida. It would seem at first as if the conclusions of Prof. Heilprin precluded the possibility of the cays being formed as suggested by Agassiz; for if we suppose a cay to be formed while the land is rising, and then that another forms

[1] Trans. Wagner Free Inst. Sci., Vol. I.

to seaward, and this process to continue until three or four cays were formed one outside of the other, it seems as if the first one would be higher above the level of the sea than the last, and this Agassiz [1] states is not the case. When I first read Agassiz's memoir I was much impressed with the strength of his arguments. But Heilprin's in regard to elevation are conclusive; and although he did not visit the lower part of the Peninsula, it is probable that its movement is in the same direction as that portion examined.

It will, however, be noticed that Agassiz lays no stress on the effects of the erosion that takes place so rapidly on all islands of coral formation.

I believe that the views of these two eminent observers can be brought into harmony by considering the effects of erosion. Let us suppose a cay has been formed of calcareous material thrown up by the waves to a height of fifteen or twenty feet. Then, while the cay to seaward was being formed, the erosion would take place on the one already made, and whether its height above the sea increased, remained constant, or decreased would depend upon the relative effects of the elevation and erosion. It is not improbable that these two forces might balance each other; and if this were so, it is easy to show diagrammatically that any number of cays could form, one after the other, to seaward, and yet the first be no higher than the last above the level of the sea. And this argument also applies to the cays near Nassau. It is probable that the ocean would throw up some of the cays higher than the others, and also that a slight difference in height would not be observed by the unaided eye.

The Formation of the Bahamas.

As stated on page 4, the islands lie on the eastern and northern edges of the Great and Little Bahama Banks. The only exceptions are Great Bahama Island, the Biminis, and some others that are exceedingly small.

As I have visited only New Providence and Andros, I hesitate to do more than suggest that the other islands of the banks have been formed by the action of the waves and wind in the same manner as the cays near Nassau.

A visit to the other islands of the group would be well repaid, for some of them, as San Salvador, Rum Cay, and Inagua, have apparently been formed in a different manner from those on the Great Bank. And it is interesting to note that Dr. Bryant [2] de-

[1] "Report on Florida Reefs," Mem. Mus. Comp. Zoöl., Vol. VII., No. 1, p. 36.

[2] Proc. Bost. Soc. Nat. Hist., XI., p. 63.

scribes Inagua as a raised atoll. And Crooked Island and Acklin together resemble in a remarkable manner the shape of the Keeling Atoll.[1] Should these be proved portions of an elevated atoll, it would be interesting, as they would be only exceeded in size by the atolls of the Maldiva Archipelago, which are the largest known.[2] The islands of the Caicos Bank also resemble the form of an old atoll, and the bank is still larger than that on which Crooked and Acklin Islands are situated.

In conclusion, it is interesting to note that Darwin and Prof. Dana, although they never visited the Bahamas, have, from a study of the charts, come to diametrically opposite conclusions in regard to the evidence they present of elevation or subsidence. Prof. Dana states[3] that "the Bahamas show by their form and position that they cover a submerged land of large area," and that "the long line of reefs and the Florida cays trending away from the land of southern Florida are evidence that this Florida region participated, though to a less extent than the Bahamas. . . . Thus the size of the islands, as well as the existence of coral banks and also the blankness of the ocean beyond, all appear to bear evidence to a great subsidence."

Darwin, on the contrary, says:[4] Proofs of elevation within recent Tertiary periods abound over nearly the whole area of the West Indies, and hence it is easy to understand "the origin of the Great Bahama Banks, which are bordered on their southern and western edges[5] by singularly-shaped islands formed of sand, shells, and coral rock, some of them about 100 feet in height, is easily explained by the elevation of banks fringed on their windward side by reefs."

I think the facts I have given justify my conclusion in regard to the recent elevation of Andros and New Providence. It is probable that the elevation extended over the rest of the Bahamas, as caves exist on the other islands. What the Bahamas are doing to-day, of course, we cannot tell; but until we have proof to the contrary, we may assume that they are rising.

This paper was illustrated by a large number of interesting specimens, and many fine lantern slides from photographs made by the author.

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[1] Darwin, "Coral Reefs," 3d ed., Pl. I., Fig. 10.
[2] Dana, "Corals and Coral Islands," p. 190.
[3] "Corals and Coral Islands," p. 368.
[4] "Coral Reefs," 3d ed., p. 268.
[5] I have quoted this as given by Darwin. It is evidently a slip of the pen, as the islands are on the eastern and northern edges of the banks

After the reading of the paper, DR. NEWBERRY made some pertinent remarks on the geology of the group, and spoke of the disputes in progress as to the rise or subsidence of the islands. DR. BRITTON asked if the soil contained much oxide of iron. In reply, DR. NORTHROP stated that he had been unable to make any exact analyses, from lack of time, but that on treating the various specimens of soil with dilute hydrochloric acid a considerable variation in them was shown. Some specimens dissolved completely, others left a large residue; these residues, tested before the blow-pipe, showed varying amounts of iron. DR. NEWBERRY explained that the limestone rocks were disintegrated by waters charged with carbonic acid; the lime being dissolved out left the silica, and oxide of iron, and alumina; these latter substances formed the nucleus of a soil. If the original rock contained much oxide of iron, we would be prepared to find it in the resulting soil. DR. BOLTON remarked that some of the specimens exhibited were similar to the rhizomorphs occurring on the Island of Niihau, H. I.

The following names were proposed for Resident Membership:

FREDERICK STARR, PH.D.,

by DR. BOLTON.

MRS. THEODORE SUTRO,

DR. JEANNETTE B. GREENE,

by DR. NEWBERRY.

October 20th, 1890.

STATED MEETING.

The President, DR. NEWBERRY, in the chair.

About fifteen persons present.

Minutes of October 13th were read and approved.

The following nominations were made for Resident Membership:

CHARLES F. PRENTICE,

by WM. L. ELSEFFER.

DR. FRANK D. SKEEL,

by DR. BASHFORD DEAN.

PRESIDENT NEWBERRY nominated as Fellow of the Academy:

DR. BASHFORD DEAN.

DR. H. T. VULTÉ read a few brief notes on

THE ANALYSIS OF GRAINS AND CEREALS.

(Abstract.)

The paper is a brief review of some of the well-known methods, but makes special reference to the Kjeldahl method for albumenoids and the Von Asboth process for starch. An outline of both is here given.

Kjeldahl Method.

Consists of two operations:—

1st. The digestion or conversion of albumenoid bodies into compounds of ammonia by means of concentrated sulphuric acid, alone or with other suitable oxidizing agents.

2d. The decomposition of the ammonium sulphate by caustic alkali, distillation, and condensation of the ammonia in standard acid.

Digestion.—From 0.8 to 1.5 gms. of the substance are introduced into a long-necked, pear-shaped flask of hard glass, from 10 to 20 c.c. of concentrated C. P. sulphuric acid, free from nitrogen, and about 0.5 gm. of metallic mercury added. The flask and contents are then placed on a ring stand and slowly heated until violent action has ceased. The heat is then increased, and continued until the solution is of a pale-yellow color; this usually takes from one-half to three-quarters of an hour. The heat is then removed, and finely pulverized potassium permanganate is cautiously added in small portions until the liquid assumes a green tinge (if pink, water is present, and reheating for some time is necessary). Heat is now applied for a few minutes, when the liquid will clear. This indicates the completion of the digestion; the heat is removed and the flask allowed to cool.

Distillation.—The contents of the digestion flask are then rinsed with about 200 c.c. of cold water into an Erlenmeyer flask

of about 700 c.c. capacity containing some spirals of platinum wire; 25 c.c. of potassium sulphide solution (containing 40 gms. per litre) are then added. The Erlenmeyer flask is fitted with a Würtz tube, and this in turn connects with a common block-tin condenser. To the drip end of the condenser is attached a tube bearing a bulb. The other end of this bulb tube dips under the surface of the liquid in the receiving flask. This flask should contain the standard acid in amount from 25 to 50 c.c., as the case demands. I prefer to use normal hydrochloric acid, but $\frac{N}{2}$ sulphuric acid may be used.

Just before starting the distillation, from 50 to 100 c.c. of caustic soda (27 per cent) are cautiously run into the distilling flask and mixed with the contents, avoiding violent agitation. A piece of red litmus paper is now dropped in the flask, which is immediately stoppered. The litmus paper serves to show whether enough alkali has been added; if not, measure out 10 c.c. more, uncork the flask, and introduce as before. Continue these additions until the contents are alkaline; but avoid a large excess. When ready, heat up slowly to boiling, and keep up the distillation until at least 150 c.c. of distillate have passed over. Remove the receiving flask, and determine the acidity of the contents with $\frac{N}{10}$ ammonia or $\frac{N}{10}$ potassium hydrate, using methyl orange as indicator.

A blank test should be made with the reagents, and under the same conditions as the original. Time of operation, two to two and one-half hours.

Calculation of Results.—The number of cubic centimetres of acid neutralized by the distillate, calculated to nitrogen and multiplied by 6.25, is equivalent to the albumenoids, *i.e.*, gluten, etc.

The determination of starch by the ordinary methods hitherto in vogue is uncertain and tedious. I refer to inversion followed by use of Fehling solution and O'Sullivan's diastase method. The first is unreliable, there being no certain method of ascertaining when all the starch has been converted into glucose; or the process may go too far, decomposing the starch to humic acid, etc.; result, low figures in both cases.

The second is a more reliable method, but there is great difficulty in preparing the diastase, which does not keep. That purchased from dealers cannot be used.

Von Asboth Process.

This depends on the fact that starch unites with barium oxide to form a compound containing 19 per cent of barium oxide.

This compound is insoluble in excess of barium hydrate, or in proof spirit.

The reagents used are as follows:

A saturated solution of barium hydrate, free from carbonate, approximately three-tenths normal.

A $\frac{N}{10}$ solution of hydrochloric acid; a $\frac{N}{100}$ solution of hydrochloric acid.

Proof spirit.

Phenol-phthaleïn, alcoholic solution.

PROCESS.

Take about 1.5 to 3.0 gms. of the dried and coarsely ground grain or flour (which should be previously thoroughly freed from fats in a Soxhlet or other extraction apparatus), place it in a small mortar, and add not more than 25 c.c. of cold water (for hard grains, as corn, etc., use hot water), rub up to a thin paste, and transfer the liquid to a 250 c.c. flask; continue the operation until all is so transferred, using not more than 100 c.c. of water. Now heat the flask over a water bath, with occasional agitation, until the starch is completely gelatinized, remove from the heat, cool, and run in 50 c.c. of the baryta solution; then stopper the flask and shake well, remove the stopper, and fill up to the mark with proof spirit; again stopper the flask and shake well for two minutes, and set aside to allow the baryta starch to settle. Now determine the value of 10 c.c. of the baryta solution in terms of $\frac{N}{10}$ hydrochloric acid. When the baryta starch has settled, remove the stopper and draw off 50 c.c. of the clear supernatant liquid, and determine the excess of baryta in it with $\frac{N}{10}$ hydrochloric acid, finishing with the $\frac{N}{100}$ acid, and using phenol-phthaleïn as an indicator. Two portions of the liquid should be so tested and the results averaged. The amount of barium hydrate originally taken (50 c.c.), less five times the excess present in 50 c.c. of supernatant liquid, is multiplied by 4.23+ and gives the weight of starch in the sample.

Barium hydrate solution should be preserved from contact with carbonic acid with jealous care, hence it is best to use a reservoir and self-filling burette, both protected by soda-lime tubes; thus guarded, a solution will maintain its efficiency for many months, but it is well in all cases to test the barium solution for each determination. Time of operation, exclusive of extraction of fat, one to one and one-half hours.

The following table will show how the factors 4.23 and 0.0324 are derived:

	Molecular wt.
Baryta starch $(C_6H_{10}O_5)_4BaO$	801
Starch $(C_6H_{10}O_5) \times$	648
Barium oxide	153

$$4(C_6H_{10}O_5) + BaO = BaO(C_6H_{10}O_5)_4$$

Hence

$$\begin{array}{c} BaO\ (C_6H_{10}O_5)_4 \\ 153 : 648 :: 1 : \times = 4.23 + \end{array}$$

Therefore 1 part of barium oxide is equivalent to 4.23+ parts of starch.

Again, the starch figure may be obtained by multiplying the difference of cubic centimetres of $\frac{N}{10}$ HCl used in neutralizing the check and actual analyses by 0.0324, a factor obtained thus: 1 c.c. of $\frac{N}{10}$ HCl contains 0.00365 gm. HCl and is equivalent to 1 c.c. of $\frac{N}{20}$ barium hydrate solution containing 0.00765 gm. BaO.

$$2HCl + BaO = BaCl_2 + H_2O$$

Hence

$$4.23 \times 0.00765 = 0.0324$$

the value of 1 c.c. of $\frac{N}{10}$ HCl in starch.

To obtain the amount of dry starch the following calculation is necessary:

Let v = quantity of water in the original grain.
" y = " " " in the extracted grain.
" z = " " fat.
" a = " " starch found in the extracted grain.

(a) $(100 - y) : a :: 100 : x$
(b) $100 : x :: (100 - v + z) : x'$

x' = the amount of starch in the original sample.

NOTE.—Dextrin is counted as starch in this process.

DR. H. C. BOLTON exhibited a few specimens of the handiwork of the natives of the Hawaiian Islands. These included specimens of *Kapa*, a kind of light cloth made of the paper mulberry and dyed of several hues; two kinds of *Leis*, or garlands of small shells; the model of a native canoe with outrigger, and a fan made of cocoanut palm. Also a fancy bag made of seeds of the *papaya*. Also, from Samoa, another fan and a mat made of *pandanus* fibre.

He spoke of the indolence of the natives, who expect a high price for any work of this character.

October 27th, 1890.

STATED MEETING.

The President, DR. NEWBERRY, in the chair.

About seventy-five persons present.

Minutes of October 20th were read and approved.

DR. NEWBERRY exhibited a fine specimen of turquoise from Mineral Park, Arizona.

The following paper was read :

RESEARCHES ON MUSICAL SAND IN THE HAWAIIAN ISLANDS AND IN CALIFORNIA.

BY DR. H. CARRINGTON BOLTON.

(Abstract.)

I. *Kauai and Niihau.*

About a year ago I presented to the Academy some account of my study of sonorous sand in the Peninsula of Sinai. That communication was in continuation of researches begun jointly with Dr. Alexis A. Julien in 1882, the results of which have been laid before you on several occasions (May 14th, 1883; March 10th, 1884; April 28th, 1884; October 15th, 1888; May 13th, 1889; October 21st, 1889). We have shown that the phenomenon of musical sand has been generally neglected by scientists, although it is of a marked character, and that the sand is widely distributed in nature, occurring on fresh-water lakes, on sea-beaches, and in arid regions.

In the spring of this year I visited the so-called "Barking Sands" of the Hawaiian Islands, already mentioned in the works of several travellers (Bates, Frink, Bird, Nordhoff, and others). As a natural curiosity the place has a world-wide fame, but the printed accounts are rather meagre in detail, and show their authors to have been unacquainted with similar phenomena elsewhere.

On the southwest coast of Kauai, in the district of Mana, sand-dunes attaining a height of over 100 feet extend for a mile or more nearly parallel to the sea, and covering hundreds of acres with the water-worn and wind-blown fragments of shells and coral. The dunes are terminated on the west by bold cliffs (*Pali*) whose base is washed by the sea; at the east end the range terminates in a dune more symmetrical in shape than the

majority, having on the land side the appearance of a broadened truncated cone. The sands on the top and on the landward slope of this dune (being about 100 yards from the sea) possess remarkable acoustic properties, likened to the bark of a dog. The dune has a maximum height of 108 feet, but the slope of sonorous sand is only 60 feet above the level field on which it is encroaching. At its steepest part, the angle being quite uniformly 31°, the sand has a notable mobility when perfectly dry, and on disturbing its equilibrium it rolls in wavelets down the incline, emitting at the same time a deep bass note of a tremulous character. My companion thought the sound resembled the hum of a buzz-saw in a planing mill. A vibration is sometimes perceived in the hands or feet of the person moving the sand. The magnitude of the sound is dependent on the quantity of sand moved, and probably to a certain extent upon the temperature. The drier the sand the greater the amount possessing mobility and the louder the sound. At the time of my visit the sand was dry to the depth of four or five inches; its temperature three inches beneath the surface was 87° Fahrenheit, that of the air being 83° in the shade (4:30 P.M.).

When a large mass of sand was moved downward I heard the sound at a distance of 105 feet from the base, a light wind blowing at right angles to the direction. On one occasion horses standing close to the base were disturbed by the rumbling sound. When the sand is clapped between the hands a slight, hoot-like sound is heard; but a louder sound is produced by confining it in a bag, dividing the contents into two parts, and bringing them together violently. This I had found to be the best way of testing sea-shore sand as to its sonorousness. The sand on the top of the dune is wind-furrowed and generally coarser than that of the slope of 31°, but this also yielded a sound of unmistakable character when so tested. A bagful of sand will preserve its power for some time, especially if not too frequently manipulated. A creeping vine with a blue or purple blossom (*kolokolo*) thrives on these dunes and interrupts the sounding slope. I found the main slope 120 feet long at its base, but the places not covered by this vine gave sounds at intervals 160 paces westward. At 94 paces further the sand was non-sonorous.

The native Hawaiians call this place *Nohili*, a word of no specific meaning, and attribute the sound caused by the sand to the spirits of the dead, *uhane*, who grumble at being disturbed; sand-dunes being commonly used for burial places, especially in early times, as bleached skeletons and well-preserved skulls at several places abundantly show.

Sand of similar properties is reported to occur at Haula,

about three miles east of Koloa, Kauai; this I did not visit, but, prompted by information communicated by Hon. Vladimar Knudsen, of Waiawa, I crossed the channel to the little-visited island of Niihau. On the western coast of this islet, at a place called Kaluakahua, sonorous sand occurs on the land side of a dune about 100 feet high, and at several points about 600 to 800 feet along the coast. On the chief slope, 36 feet high, the sand has the same mobility, lies at the same angle, and gives when disturbed the same note as the sand of Kauai, but less strong, the slope being so much lower. This locality has been known to the residents of the island for many years, but has never been before announced in print. This range of dunes, driven before the high winds, is advancing southward, and has already covered the road formerly skirting the coast.

The observations made at these places are of especial interest because they confirm views already advanced by Dr. Julien and myself with regard to the identity of the phenomena on sea-beaches and on hillsides in arid regions (Jebel Nagous, Rig-i-Rawan, etc.). The sand of the Hawaiian Islands possesses the acoustic properties of both classes of places; it gives out the same note as that of Jebel Nagous when rolling down the slope, and it yields a peculiar hoot-like sound when struck together in a bag, like the sands of Eigg, Manchester, Mass., and other sea-beaches—a property that the sand of Jebel Nagous fails to possess. These Hawaiian sands also show how completely independent of material is the acoustic quality, for they are wholly carbonate of lime, whereas sonorous sands of all other localities known to us (now over one hundred in number) are silicious, being either pure silex or a mixture of the same with silicates, as feldspar.

In 1875 Dr. James Blake, of San Francisco, examined microscopically a specimen of the Kauai sand sent him by Mr. Frink, and ascribed its acoustic qualities to the cellular character of the grains. This condition, however, Dr. Julien and I find to be exceptional, since most sonorous sand is quartzose, and we believe the gaseous-film theory, already announced to the Academy, applies equally to sonorous sand of diverse form, composition, and origin.

A specimen carried away in a bag, and another shipped over land in a keg, have both preserved their acoustic qualities up to date.

[The speaker exhibited specimens, and obtained a low hoot like sound by clapping together sand confined in a bag. The subject was also illustrated by numerous original photographs (projected on a screen) of the Nohili, and of scenery on the island of Kauai.]

II. *California.*

In previous communications we have enumerated over 70 localities of musical sand in the United States. With few exceptions, all of these were on the Atlantic coast, our efforts to secure by correspondence information as to the Pacific coast having been at that time rather unsatisfactory.

During the earlier part of this summer I examined in person the sea-coast of California at several points, and with the following results. Beginning at the southern extremity of the State, I first visited

1. *Coronado Beach, San Diego.* At this agreeable spot sonorous sand occurs in abundance, though of inferior quality. I first noticed it alongside of Prof. Henry A. Ward's Museum of Natural History, near the Hotel del Coronado, and traced it at intervals for more than 1,500 feet west and the same distance east of this place; as the beach appears to be uniform in character, it probably occurs throughout the entire length, about ten miles. The musical sand occupies areas of various sizes in a belt six to twenty feet wide above the ordinary high-tide line; a less sonorous variety, emitting a shriller note, also occurs below the high-tide line on the surface only. Under the foot the sand is distinctly sonorous, and a tingling sensation is perceived in the toes when thrust into it forcibly; but these phenomena were less marked at the time of my visit than they are at Eigg, Manchester, Mass., Rockaway, N. Y., and other places. In a bag a loud sound is obtained. There are no dunes in the immediate vicinity. The areas of loudest intensity evidently change their position from day to day, or season to season; a certain area giving notable results one afternoon became moistened by an unusually high tide during the night and was thus deprived of its acoustic properties.

2. *Santa Barbara.* Very weak, superficial sonorous sand was detected on the bathing beach near the long pier. The locality is unfavorable, owing to abundance of algæ and narrowness of the sand-belt.

3. *Redondo Beach, near Los Angeles.* No sonorous sand was detected at the time of my visit (July 2d).

4. *Monterey.* Affirmative results at two places. On the bathing beach near the much-frequented Hotel del Monte is a tract of loose sand highly sonorous, equal, apparently, in power to that of Manchester, etc.; also at Moss Beach on the so-called seventeen-mile drive. The sand here is unusually white and transparent, and is fairly sonorous on the surface.

5. *Pescadero.* Sonorous sand has been reported by several

persons to occur near the pebble beach of Pescadero, and particulars were communicated to us in 1885 by Mr. J. W. Redway, so I did not personally examine this region.

6. *San Francisco.* Extensive sand-dunes form a conspicuous feature in the ocean suburbs of San Francisco. Powerful winds from the broad Pacific drive the sand city-ward and formerly threatened to submerge a shifting real estate—a region of "sand-lots," world-notorious through the pseudo-oratory of a mischievous demagogue.

Recently scientific arboriculture has reclaimed a large tract for the Golden Gate Park. Extensive dunes still remain, some of them measuring 50 to 60 feet on their steepest incline; on the lee side the sand lies at the angle of rest, which here is 31°, the same as in Egypt, Bermuda, and the Hawaiian Islands. In the dry season the sand is quite mobile, but, notwithstanding these favorable conditions, it is utterly devoid of sonorous properties, owing to its shaly and siltose constitution. The beach sand south of the Cliff House is also non-sonorous for the same reason.

7. *Laguna Beach.* This beach lies on the ocean about five miles north of Golden Gate, and was reached via Saucelito. The sand here, too, is shaly and wholly non-sonorous. Reporting the occurrence of non-musical sand may be uninteresting, but is not altogether superfluous, for negatives are of importance in establishing affirmatives.

8. *Mexico.* Mr. W. Waddell, now in Brazil, but a resident of Mexico for fifteen years, has furnished me with data of a sonorous sand-hill in the Peninsula of Lower California. A gentleman of accurate thought and a close observer of nature, he responded to my pertinacious questioning in so satisfactory a manner as to leave no doubt concerning the nature of the phenomenon and the character of the locality.

In the year 1885, just before the close of the dry season, Mr. Waddell was with a party of Mexicans on a schooner fitted out for the capture of turtles. They coasted along the Pacific shore of Lower California and made landings at many points. About 60 miles north of Cape San Lucas, the extreme southern end of the Peninsula, the party landed, and one of them climbed to the top of a dune to get a view of the neighborhood—in short, to prospect for turtles—and observed a sound issuing from the dry loose sand disturbed by his act. Mr. Waddell, standing near, also heard the sound, and, having previously read of the Mountain of the Bell, at once recognized the phenomenon. This dune is about 70 feet high (memory-measure), and shaped like the half of a lens; its sides are covered in part with plants common to

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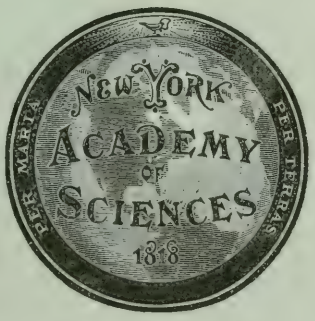

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the region ; it forms one of a range parallel to the coast, and the sonorous slope faces the sea. The sand consists of ordinary quartz intermingled with a few broken shells. The sound produced by the sliding sand Mr. Waddell likened to that of bells, or rather to that made by rubbing the moistened finger on the edge of a glass bowl ; not having a musical ear, he was unable to recall the pitch.

The phenomenon was known to some of the Mexicans in the party, who narrated the following legend : Many centuries ago there was a flourishing monastery at this place, but, owing to the wickedness of the monks, it was overwhelmed by drifting sand. The monastery bells, however, were not involved in the fall of the monks, having been blessed with due ceremony by high ecclesiastics, hence the sound of these holy bells is still heard at matins and vespers. The tradition resembles that of Jebel Nagous, Arabia, so far as the monastery bells are concerned, but is ingenious in accounting for both the underground state of the priestly establishment and the survival of the music-yielding bells.

There are no villages in the vicinity of this sand-hill, and the ranches in the arid and desolate Peninsula are widely scattered ; there is no business for commercial men, no attraction for tourists, and the region is rarely visited by scientific travellers.

III. *Additional Localities—Theories.*

Several localities of peculiar interest have been reported to Dr. Julien and myself, which I desire to place on record, especially as by so doing public thanks can be given to informants. While sonorous sand has been shown to occur on the shores of fresh-water lakes, on sea-beaches, and in arid regions far removed from the sea, we have had no proof until recently of its occurrence on rivers. Mr. William De M. Hooper, of Indianapolis, reports observing musical sand on the east bank of the river Wisconsin, about two and one-half miles above Kilbourn City, Wis. It lies in several banks near the mouth of a small gulch leading into the river. The scenery of the so-called Dells of the Wisconsin is very picturesque and attracts many visitors. It was in company with Prof. Fifield, of New Haven, and on July 13th, 1886, that this locality was noted. The river was low at the time, and the dry sand loudly sonorous.

Similar phenomena were observed on a shallow spot in the Mississippi River, opposite Carondelet, by Mrs. Stoltz and her brother, of Waimea, in September, 1875. Being familiar with the Barking Sands of Kauai, only ten miles from her home, the lady collected samples from the river and exhibited them to

many persons. Mrs. Holmes, wife of the State Geologist of North Carolina, has observed musical sand on the banks of Cape Fear River, a few miles above Wilmington, N. C. Mr. A. Sidney Olliff, writing to *Nature*, reports sonorous sand at Botany Bay, New South Wales, not far from the spot where Capt. Cook first landed. Prof. Liversidge, of the University of Sydney, has kindly sent us a specimen of sonorous sand from Brown's River Bay, Tasmania. Mr. L. H. Jacoby, a Fellow of this Academy, brought us a specimen from Cape Ledo, West Africa. Lieut.-Commander Frederick A. Miller, U. S. N., had previously reported its occurrence on the landing beach at Liberia, West Africa. Mr. Henry C. Hyndman, in a recent letter to *Nature*, calls attention to a mention of sonorous sand by Andrew A. Anderson in his work, "Twenty-five Years in an African Wagon" (1887); the locality therein named is on the west side of the Langberg mountain, in West Griqualand, on dunes 500 to 600 feet in height.

These notes confirm our views, published in 1884, that musical sand is really abundant throughout the world, and has only lacked a biographer to bring it before the public.

In a paper read before the Bournemouth Society of Natural Science by Mr. Cecil Carus-Wilson, in 1888, the author, after liberal quotations from abstracts of our communications to the Academy, announces as his theory that the musical notes result from the "rubbing together of millions of clean sand-grains very uniform in size." This he reaffirms in a recent letter to *Nature* (October 9th, 1890). Dr. Julien and I regard this theory as insufficient to explain musical sand, but well adapted to explain *squeaking* sand. Two distinct classes of sounds are produced by disturbing sand, both undoubtedly due to vibrations. The more common sound is caused by attrition of the particles, and has a well-known harsh character by no means musical; it is sometimes heard when wagon-wheels crush through sand, and in very rare cases this becomes a loud squeak. The second sound is caused, we believe, by oscillations of the particles themselves, protected from actual contact by elastic air-cushions, and this is decidedly musical in tone.

Musical sand yields notes by friction only when *dry;* squeaking sand yields a harsh, shrill sound (reminding one of the cry of a guinea fowl), best when *moist.* This latter variety is very rare; we have collected, by correspondence and in person, more than 600 samples of sand from around the world, and musical sand seems to be comparatively common; but only two localities of squeaking sand are known to us, both in so-called boiling springs—one in Maine and the other in Kansas. A very small

quantity of squeaking sand pressed between the thumb and forefinger produces, when wet, a peculiar, shrill squeak—a phenomenon which we think well explained by the attrition theory. The magnificent acoustic display which I have witnessed in the Desert of Sinai, and the somewhat less striking phenomenon at Kauai, are, however, manifestly due to greater freedom of oscillatory motion than is possible if the particles merely scrape against each other.

Mr. Carus-Wilson announces a second edition of his paper on musical sand. Dr. Julien and I await it with peculiar interest, and shall be very much obliged to him for giving a large circulation to the results we have obtained by extended travel and years of study, though we would prefer to present the results to the scientific public in our own way.

[*Specimens Exhibited.*—Musical sand from Mana, Kauai, and from Kaluakahua, Niihau. Also, for comparison, from Jebel Nagous, Arabia. Musical sand from Masconomo Beach, Mass., that was collected and bottled July 9th, 1884. This, when tested in a bag, gave the characteristic sounds, easily heard by the entire audience. Also two bags from Rockaway, L. I., collected in 1885 and kept free from dust in a tin box. These still preserve their musical power. The large bag of sand from Kauai gave a much deeper musical note than the smaller bags from Massachusetts and New York. Also very coarse black lava sand from Punaluu, Hawaii; ditto (finer) from Hilo, Hawaii; olivine sand from Kaumuhonu, Niihau; volcanic ash from below surface in Honolulu; squeaking sand from Maine; and following rocks: amygdaloid from the Pali, Honolulu; the same from Haleakala, Maui; scoriaceous and massive lava from the same; oo-vesicular lava from Mauna Loa, Hawaii; lava collected only twenty-four hours after flowing from Dana Lake, crater of Kilauea, Hawaii.]

At the close of the paper the subject was discussed by Dr. Julien and Prof. D. S. Martin.

November 3d, 1890.

Regular Business Meeting.

The President, Dr. Newberry, in the chair.

About twenty-five persons present.

The minutes of October 27th were read and approved.

The following recommendations of the COUNCIL (October 30th) were read, and the persons mentioned duly elected :

1. The acceptance of the resignation of JUDGE R. L. LARREMORE, who withdraws from the Academy on account of failing health.
2. The election of DR. BASHFORD DEAN as Fellow.
3. The election of the following Resident Members :

FREDERICK STARR, PH.D.,
MRS. MATILDA SUTRO,
DR. JEANNETTE B. GREEN,
CHARLES F. PRENTICE,
DR. FRANK D. SKEEL.

4. The election as Corresponding Member of PROF. W. D. ALEXANDER, of Honolulu, Hawaiian Islands.
5. The payment of sundry bills amounting to $55.82.

A letter was read from the New York Camera Club, inviting the Fellows and Members of the Academy to an exhibition of photo-mechanical processes at the Club Rooms on Fifth Avenue. The Recording Secretary was directed to accept the invitation and convey the thanks of the Academy to the Camera Club for their kind invitation.

DR. J. S. NEWBERRY then read the paper announced for the evening, entitled

ON THE GEOLOGICAL AGE AND RELATIONS OF THE POTOMAC GROUP OF VIRGINIA AND MARYLAND.

This paper was of great value, but on account of the sudden and severe illness of Dr. Newberry no abstract can be given in the current number.

At the close of the paper DR. HUBBARD asked whether this formation underlies the city of Richmond. At Dutch Gap, near the city, the Potomac River is very rapid and makes a bend of six or seven miles. Near this place an artesian well was sunk some three or four hundred feet into shell marl, and no rock was encountered or water found.

DR. BOLTON announced that the second annual meeting of

the American Folk-lore Society would be held at Columbia College on Friday and Saturday, November 28th and 29th, and suggested that the Academy hold a joint meeting with the Folk-lore Society on Friday evening, November 28th. Adopted.

The following Committee on Revision of the By-Laws was announced at this meeting:

H. Carrington Bolton,
N. L. Britton,
Silas B. Brownell,
C. F. Cox,
J. S. Newberry.

November 10th, 1890.

Stated Meeting.

The President, Dr. Newberry, in the chair.

About fifteen persons present.

The minutes of November 3d were read and approved.

Dr. Britton made some interesting remarks on some Raritan clays which are slightly ferruginous, possibly not available for high-grade refractory material. The bed is thirty-five feet thick, whitish in color, and contains no fossils.

Dr. Alexis A. Julien read the paper announced for the evening, entitled

ON THE MICROBE OF PHOSPHORESCENT WOOD.

(Abstract.)

The phosphorescence of wood has been often supposed to be connected with the green coloring produced by certain fungi, especially *Peziza Jungermanniæ* and *P. æruginosa*. On an examination of a large number of samples of such green decayed wood, collected in the Adirondack Mountains in 1889, not a single specimen was found to be phosphorescent; and this fact serves in confirmation of the similar conclusion of Ludwig, Zukal, and others. However, I have noticed, in some cases, that the cells

may contain large numbers of micrococci, and that these may be actually colored green—by a natural process of staining, apparently unique in nature—by the green coloring matter diffused from the fungus through the woody tissue.

On the other hand, specimens of brightly phosphorescent decayed wood, recently obtained in the Adirondacks, were found to be uniformly uncolored. The cells were turgid with liquid, apparently in unusual degree, and contained the mycelium of a hymeno-mycetous fungus (as yet not identified), whose hymenia were scattered over the exterior surface of the decayed tree. The phosphorescent agency, however, was found in vast numbers of a microbe of micrococcous form, mostly spherical, of wide variation in size, from 0.2 to 3.0 microns or more in diameter. These were scattered, or gathered in a variety of groups, diplococci, chains, bunches, etc., and even found sprouting out into rods, some of which passed into short articulated hyphæ, like those constituting the mycelium above referred to. The source of these micrococci was shown in larger oval sacs, 9 by 7 microns in length and breadth, apparently derived from the mycelial threads, some being found still filled with the micrococci of very small size.

On squeezing the liquid out of the cells of the wood upon thin glass covers, the latter were rendered phosphorescent. The organism refused to grow upon the ordinary culture media, though the fragments of phosphorescent wood could be kept in full vigor and brightness for two weeks in a moist chamber. The film of micrococci upon the dried thin covers was readily stained by campechian (Löffler's solution).

The general literature on the phosphorescence of fungi and of wood was discussed, from the papers of Dr. Robert Boyle in the year 1667, down to the more recent investigations of Ludwig, Fischer, Arcangeli, Patouillard, etc.

November 17th, 1890.

STATED MEETING.

The President, DR. NEWBERRY, in the chair.

About ten persons present.

The minutes of November 10th were read and approved.

DR. BOLTON nominated as Resident Member

SYDNEY A. SMITH, A.B.

DR. FREDERICK STARR read the paper announced for the evening, entitled

SOME WINNEBAGO ARTS.

(Abstract.)

It is well known that a tribe may have peculiarities in speech, in manners, in arts, that distinguish it at once from its neighbors. The Haida carves slate as no other tribe does. The elegant blankets of mountain sheep wool from Chilcat are characteristic. The Hebrews tested the enemy with the word *shibboleth*, and found that he could only say *sibboleth*. A twist of the tongue in pronouncing a word is a small matter, but, small as it is, it may be perpetuated for ages.

Such a perpetuation of a tribal peculiarity has been aptly called an ethnic survival. Some of the advanced linguists of the present day are beginning to query whether the group of modern languages of the Aryan family are not examples of such ethnic survival; whether the differences between French and Italian and Spanish, Latin, Greek, and Slavonic, are not due to the difficulty various ancient tribes found in learning to speak the same new and foreign language. To draw an example of ethnic survival from another field of science, consider the art of the French cave-men. The archæologist finds in the caverns bones of various mammals, teeth of cave-bear, and antlers of reindeer carved with animal figures. The art is *good* for a barbarous people, but it is certainly barbarian art. The range of designs is quite great: horses, bears, mammoths, reindeer are among the figures. The people who did this work were an artistic people. To carve and represent animal forms was almost a mania with them. An ethnic impulse seems to have driven them on to such work, just as a similar impulse drives the Haida slate carver to-day; just as a

similar impulse has driven the Bushman to cover the walls of his caves in South Africa with pictures whose boldness and fidelity are the amazement of all who see them.

We have, then, in the French cave-dwellers a people who had a well-defined art, and who, as art workers, were isolated and unlike all neighbors. An eminent English scientist believes that neither they nor their art are gone. There is a people who to-day lives much as the cave-man of France lived so long ago, who hunts and fishes as he did, who dresses as he did, who builds houses in whose architecture some think they can see evidence of a cavern original, who above all still carves batons from ivory, and implements from bone, adorning them with skilfully cut figures of animals and scenes from the chase. This people is the Eskimo. If Dawkins' view is true, we have in the Eskimo carvings of to-day a true ethnic survival—an outcropping of the same passion which displayed itself in the mammoth carving of La Madelaine.

Scarcely anything in the range of American antiquities has caused more wonder and led to more discussion than the Animal Mounds of Wisconsin. We do not pretend to explain their purpose. Perhaps they were village guardians; perhaps tribal totems marking territorial limits; some may have been of use as game drives; some may even have served as fetich helpers in the hunt, like the prey gods of Zuñi. We may never know their full meaning. It is sufficient here for me to remind you what they are and where. They are nearly confined to a belt of moderate width, stretching through Wisconsin and overlapping into Minnesota and Iowa. Within this area they occur by hundreds. Dr. Lapham published a great work on the Effigy Mounds in 1855, in which he gave the results of many accurate surveys and described many interesting localities. Since his time no one has paid so much attention to the effigies as Stephen D. Peet, editor of the *American Antiquarian*, whose articles have during this year been presented in book form. Mr. Peet has paid much attention to the kind of animals represented, and has, it seems to us, more nearly solved the question than any one else. He recognizes four classes of animals—land animals or quadruped mammals, always shown in profile; amphibians, always shown as sprawling, with all four feet represented; birds, recognized by their wings; and fishes, characterized by the absence of limbs of any kind. The land animals are subdivided into horned grazers and fur bearers. Of the many species he claims to find, it seems to us the most satisfactorily identified are the buffalo, moose, deer, or elk; the panther, bear, fox, wolf, and squirrel; the

lizard and turtle; the eagle, hawk, owl, goose, and crane; and fishes. One or two man mounds are known, although most of those so-called are bird mounds—either the hawk or the owl. Sometimes, too, "composite mounds" are found. Nor are these mounds all that are found. Occasionally the same forms are found *in intaglio*, cut into the ground instead of being built above it, but just as carefully and artistically made. Notice, in addition to the form of these strange earth-works, that they are so skilfully done that the attitude frequently suggests action or mood. Nor are they placed at random, but are more or less in harmony with their surroundings. Remember, too, their great number and their large size—a man 214 feet long, a beast 160 feet long with a tail measuring 320 feet, a hawk 240 feet in expanse of wing.

They are *unique*. To be sure, there are in Ohio three effigies, in Georgia two, and in Dakota some bowlder mosaics in animal form. None of these, however, are like the Wisconsin type. The alligator and serpent of Ohio are different in location and structure from the Wisconsin mounds, and are of designs peculiar. The bird mound in the Newark circle is more like a Wisconsin effigy, but it is associated with a type of works not found in the effigy region. The birds of Georgia are different in conception, in material, and in build. The mosaics of Dakota are simply outlines of loose bowlders.

It seems to us that the effigy builders of Wisconsin were a peculiar tribe, unlike their mound-building neighbors in Ohio or the South; that they were a people with a passion for representing animal figures. This passion worked itself out in these earth structures. That a single tribe should be thus isolated in so remarkable a custom is no more strange than that the Haida should carve slate or the Bushman draw his pictures on his cavern walls.

Who were the effigy builders? This is a question often asked and variously answered. Some writers would refer them to the Winnebagoes, or, if not to them directly, to some Dakota stock from which the Winnebagoes have descended.

Formerly I was a frequent visitor to the Sac and Fox Reservation in Iowa. About 400 of the tribe are left. To an unusual degree they retain the old dress, language, arts, and dances. With them lived a few Winnebagoes. In general the lives of the two peoples are similar. Certain arts common to both of them particularly interested me. They are the making of sacks of barks and cords, and the weaving of bead bands for legs and arms, upon the *ci-bo-hi-kan*. Of the bark sacks there are several pat-

terns, the simplest being made of splints of bark passing alternately over and under each other. Another kind, far more elaborate in construction, is before you. Yet more elaborate ones are made entirely of cords. The first of these I saw was in old Jennie Davenport's wikiup. It was of white and black cords, and the black ones were so manipulated as to form a pattern—a line of human figures stretching across the sack. Jennie would not sell it, as she said "it is a Winnebago woman's sack; Fox woman not make that kind." I found afterward a large variety of these Winnebago sacks, and all were characterized by patterns of men, deer, turtles, or other animals. Not one Fox sack of such pattern was to be found, though many elaborate and beautiful geometrical designs were shown me.

The most beautiful work done on this reservation is the bead-weaving on the ci-bo-hi-kan—woven work, *not* sewed, remember. In appearance the result is like the Iroquois wampum belts, but the management of the threads is dissimilar. The Sac and Fox patterns are frequently complex and beautiful, but always geometrical. We have seen hundreds of them, but none with life forms. The Winnebago belts, made in exactly the same way, frequently, if not always, present animals or birds or human beings.

This, it seems to us, is very curious. Here are people of two tribes living side by side, with the same mode of life and the same arts, but in their art designs so diverse. It is a case parallel to that of the old effigy builders, a people who have a passion for depicting animal forms—a passion not shared by their neighbors.

If this were the only evidence that the Winnebagoes built the effigy mounds, or that their ancestors did so, it would have no great weight. But the claim has been made already on other grounds. This being the case, we think that this adds something to the testimony, and we ask, *Have we here an ethnic survival?*

At the close of the paper DR. STARR exhibited a number of fine specimens of Indian handiwork, including woven work, bags, belts, etc.

DR. NEWBERRY explained that these mounds were not sepulchral, like many others in the Ohio and Mississippi valleys. Geologically speaking, man is very recent. The early inhabitants of America may have originally come from the East, but, if so, they were cut off from that part of the world at a very early date. The development of the tribes in America was complete and far-reaching. Copper and lead mines were worked, the forests re-

moved, and large tracts given over to the cultivation of corn, grain, etc. This was the Mound Age, and these constructions were certainly abandoned over one thousand years since. The Pueblo Indians now existing in Arizona and New Mexico took their origin from Central America and spread as far north as Salt Lake, Utah, and south as far as Chili. Their structures were permanent stone buildings, many of which still exist in a good state of preservation.

Prof. Munroe found rocks on the Ohio River, near the Pennsylvania line, inscribed with figures of men, horses, and other animals. At low water these figures can be distinctly observed.

Dr. Newberry announced that the next meeting of the Geological Congress would be held in Washington, D. C., August 26th, 1891; that of the American Association for the Advancement of Science at the same place August 19th, 1891.

Dr. H. C. Bolton spoke briefly on the remarkable addition to chemical knowledge recently made by Prof. Th. Curtius, of Kiel, viz., a new strong acid called in German "Stickstoffwasserstoffsäure"—in English *hydrazoic acid*—having the formula

$$HN_3;\ \text{or, } H-N\begin{cases} N \\ \| \\ N \end{cases}$$

Curtius obtained it in several ways, the most convenient method being by converting hippurylhydrazin into nitrosohippurylhydrazin, and decomposing the latter with alkali.

$$\underset{\text{Nitrosohippurylhydrazin.}}{C_6H_5CONHCH_2CO.\ N\begin{cases} NO \\ NH_2 \end{cases}} = \underset{\text{Hippuric acid.}}{C_6H_5CONHCH_2COOH} + \underset{\text{Hydrazoic acid.}}{HN\begin{cases} N \\ \| \\ N \end{cases}}$$

The new acid is a gas, having a frightful suffocating odor, irritating the mucous membrane and producing headache. It is very soluble in water, yielding a strong acid solution, like hydrochloric acid. This solution dissolves iron, zinc, copper, aluminium, and magnesium, with liberation of hydrogen and formation of nitrides of the metals. With salts of silver and mercury white precipitates are formed resembling chlorides of these

metals, but the silver compound is not blackened by light; the mercurous, copper, and ferrous salts are explosive.

Advantage is taken of the insoluble silver salt to prepare the acid in a pure state; boiled with dilute sulphuric acid it yields hydrazoic acid. An aqueous solution containing 27 per cent of the gas is much heavier than water and sinks to the bottom of the vessel into which it is poured. The solution yields white clouds with ammonia, just like hydrochloric acid. Prof. Curtius plans to build up an entire new series of nitrogen compounds of greatest interest to the chemical world.

Dr. Bolton spoke of the great importance of the discovery of the new strong acid from industrial, analytical, and physiological points of view.

November 24th, 1890.

STATED MEETING.

The President, DR. NEWBERRY, in the chair.

About two hundred persons present.

The minutes of November 17th were read and approved.

DR. BOLTON announced that a joint meeting of the Academy and the American Folk-lore Society would be held at Columbia College, Friday evening, November 28th, at 8 o'clock.

PRESIDENT NEWBERRY announced the opening of the Public Lecture Course of 1890-1891, and introduced MR. FREDERICK H. CHAPIN, of Hartford, Conn., who spoke on the

CLIFF DWELLINGS OF THE MANCOS CAÑONS.

The lecture was highly novel and interesting, and was illustrated by a large number of lantern views taken by the lecturer.

At the close of the entertainment a vote of thanks was unanimously given MR. CHAPIN.

November 28th, 1890.

SPECIAL MEETING, JOINTLY WITH THE AMERICAN FOLK-LORE SOCIETY.

DR. DANIEL G. BRINTON, President of the American Folk-lore Society, in the chair.

About one hundred and twenty persons present.

MR. W. W. NEWELL read a paper on

THE PRACTICE OF CONJURING NOXIOUS ANIMALS, AS SURVIVING IN THE FOLK-LORE OF NEW ENGLAND.

MR. GEORGE F. KUNZ exhibited a remarkable and valuable collection of rare objects of folk-lore interest, and read an annotated catalogue of the same.

MR. L. J. VANCE read a paper entitled

THREE LESSONS IN RHABDOMANCY,

which was discussed by MR. MONCURE D. CONWAY, MR. STEWART CULIN, and others.

DR. H. CARRINGTON BOLTON read a paper entitled

SOME HAWAIIAN PASTIMES,

and illustrated it by objects from Niihau, Hawaiian Islands, and by projections of original photographs.

DR. JOHN S. NEWBERRY exhibited the following objects: A prehistoric bronze bell from Japan; a peculiar corn-muller from Central America; and a half-finished stone axe, showing the method of boring the hole, from the Swiss lake dwellings. Dr. Newberry also exhibited the lantern slides illustrating his paper on "The Ancient Civilizations of America—Date and Derivation," but, owing to the lateness of the hour, did not present the paper, save in brief abstract.

December 1st, 1890.

REGULAR BUSINESS MEETING.

The President, DR. NEWBERRY, in the chair.

Five persons present.

There being no quorum for the transaction of business, the meeting adjourned to December 8th, 1890.

December 8th, 1890.

ADJOURNED BUSINESS MEETING.

About twenty-five persons present.

DR. BOLTON announced the illness of the President, DR. NEWBERRY, and called on PROFESSOR J. K. REES to preside.

The minutes of the meetings of November 24th and 28th and December 1st were read and approved.

The following recommendations of the COUNCIL (November 26th) were read and approved, and the member duly elected:

I. The payment of the following bills:

M. A. Knight, wrapping and addressing.....	$13.25
W. R. Jenkins, card notices of meetings.....	14.25
	$27.50

II. The election of MR. SYDNEY A. SMITH as Resident Member.

The Treasurer reported that the cash balance on November 25th was $687.46.

DR. ORVILLE A. DERBY, OF RIO JANEIRO, BRAZIL, was proposed as Corresponding Member.

The following resolution was presented by DR. BOLTON, and unanimously approved:

We, the Fellows and Members of the New York Academy of Sciences, having learned with great regret of the sudden ill-

ness of our highly esteemed President, DR. JOHN S. NEWBERRY,

Resolve, That we extend to him our deep sympathy, and express the hopes that his recovery may be speedy and complete, and that he may soon be restored to his posts of usefulness and honor.

Resolve, That this resolution be entered in the minutes, and that a copy be sent to PRESIDENT NEWBERRY.

MR. HAROLD JACOBY, of Columbia College, then read the following paper, entitled

THE UNITED STATES ECLIPSE EXPEDITION TO WEST AFRICA, 1889–90, *illustrated by Projections of Original Photographs.*

(Abstract.)

December 15th, 1890.

STATED MEETING.

The Vice-President, DR. HUBBARD, in the chair.

About two hundred and twenty-five persons present.

The minutes of December 8th were read and approved.

The name of

MR. J. FOSTER HIGGINS

was proposed as Resident Member.

It was resolved that when the Academy adjourn, it would adjourn to meet January 5th, 1891.

The second lecture of the Public Course was then delivered by Dr. H. CARRINGTON BOLTON, entitled

LIFE AND SCENES IN THE HAWAIIAN ISLANDS, *illustrated by Projections of Original Photographs.*

WANTED.

TRANSACTIONS, VOL. I., ...	Parts 2 and 4.
ANNALS, VOL. II., ...	Pages 288–357.

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H. CARRINGTON BOLTON,
Recording Secretary.

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Late LYCEUM OF NATURAL HISTORY.

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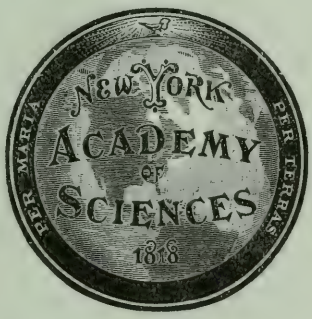
1890-1891.



EDITED BY

THE RECORDING SECRETARY,

ASSISTED BY

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January 5th, 1891.

REGULAR BUSINESS MEETING.

VICE-PRESIDENT DR. HUBBARD in the chair.

About forty persons present.

Minutes of the previous meeting were read and approved.

The following recommendations of the COUNCIL were read and approved, and the members mentioned duly elected :—

I. The appropriation of $275.95 to pay outstanding bills approved by the COUNCIL.

II. The election of DR. ORVILLE A. DERBY, of Rio Janeiro, South America, as Corresponding Member, and MR. J. FOSTER HIGGINS as Resident Member.

III. Acceptance of the resignation of MRS. MARTHA J. LAMB.

IV. The appropriation of $25 for office expenses of the Recording Secretary.

The Recording Secretary then presented the Revised By-Laws, as recommended by the COUNCIL, and announced that action would be deferred to the next regular business meeting, February 2d. A copy of these proposed amendments was, by order of the Academy, mailed to each Resident Member and Fellow.

VICE-PRESIDENT HUBBARD then announced the joint meeting of the Section of Mineralogy with the New York Mineralogical Club.

MR. GEORGE F. KUNZ, acting as Secretary, read the minutes.

Specimens were exhibited as follows :

Quartz pseudomorphs from Hoxie's Quarries, Paterson, N. J.

Beryls, garnets, and orthoclase from Manhattan Island.

MR. GEORGE F. KUNZ read a paper on

THE DISCOVERY OF DIAMONDS AT PLUM CREEK, ROCK ELM TOWNSHIP, PEARCE COUNTY, WIS.,

and one on

THE DISCOVERY OF FIRE OPALS NEAR WHELAN, WASHINGTON STATE.

[Both these papers will be printed by the Geological Society of America, Vol. II., 1891.]

He also read a paper on

THE PHOSPHORESCENCE OF THE DIAMOND AFTER EXPOSURE TO SUNLIGHT, AND ALSO BY FRICTION.

Only blue-white diamonds possess the property of emitting light after exposure to sunlight, but all diamonds, when rubbed in the dark on a rough board, tile, metal, leather, or cloth, phosphoresce in different degrees of intensity, resembling the light produced by the glow-worm or a phosphorus match. The stones that emit light after exposure to sunlight show this to a much greater degree. Dr. Robert Boyle virtually announced all these facts about the diamond more than two hundred and thirty years ago.

A paper describing the two meteorites (one of one hundred and eighty and one of ten pounds) from Washington County, Kansas, and a thirty-pound meteoric iron from Floyd County, Virginia, will be published later on.

MR. GILMAN S. STANTON read a paper on

THE OCCURRENCE OF BERYLS AND GARNETS ON NEW YORK ISLAND.

(Abstract.)

I have been requested to exhibit to the Academy some beryls and garnets which I obtained from a vein at 65th street and Ninth, or Columbus, avenue of this city. A number of the members of the Mineralogical Club know of this vein, but, as it has recently yielded some large beryls, perhaps a short description of it would be of interest.

Nearly three years ago I first discovered that this vein contained a remarkable quantity of interesting, beautiful, and exceedingly perfect crystals of garnet. For about a month, while the blasting continued, I succeeded in getting a large number of specimens. The vein, which was of a coarse granite, cut a light-colored variety of the gneiss of this city and averaged some

three feet in width. The mica of the granite was muscovite, often in imperfect crystals seven inches across and as much in thickness. The smoky quartz and orthoclase occurred in correspondingly large masses, the orthoclase sometimes being crystallized.

The garnets were most plentiful at the junction of these two minerals, usually upon a face of an orthoclase crystal. The garnet faces in the orthoclase were generally flattened, as the numerous shallow casts on the specimens here indicate. Crystals from the smoky quartz were fewer, but much lighter in color and more translucent. Some of the groups are very beautiful. One consists of fifty-nine crystals about three-eighths of an inch in diameter, and nearly as many more casts, on a part of an orthoclase crystal ten by eight by four inches.

An interesting feature of the garnets was their crystalline form. They were the combination of the trapezohedron truncating the rhombic dodecahedron, the faces of each being about equally prominent. The largest crystal was one and a quarter inches in axial diameter. Few were less than one-quarter of an inch. One specimen on the table shows faces of the hexoctahedron, in addition to those before mentioned, thus giving the crystal the appearance of rounded edges.

As the blasting continued the character of the granite changed. The muscovite was smaller, and oligoclase in masses nearly as large as the orthoclase became common. The garnets were scarcer, and their crystalline form was generally the unmodified trapezohedron. To my knowledge no simple dodecahedrons were found.

The blasting was shortly discontinued, and was only recommenced a short time ago. Garnets were, however, comparatively few and imperfectly crystallized trapezohedrons. While searching, with the hope that some good garnets might still remain, a half-inch beryl was found, and shortly afterward a large jointed crystal in all some ten inches long. It was impossible to get this crystal out whole. The best piece is upon the table. The crystal was intersected at the joints by seams of quartz, reminding one of many tourmaline crystals of this city. Although not clear or colored enough to be called emeralds, fractures and splinters show them to be quite glassy and translucent.

Besides the minerals already mentioned, some tourmaline and a small black crystal in orthoclase, possibly columbite, have been taken from this vein.

I am inclined to think the vein metamorphic in its origin, and it evidently cooled slowly and with but little disturbance.

DR. H. T. VULTÉ was proposed as Fellow of the Academy by PROF. N. L. BRITTON.

January 12th, 1891.

STATED MEETING.

VICE-PRESIDENT DR. HUBBARD in the chair.

About thirty-five persons present.

Minutes of January 5th were read and approved.

The following paper was read :

BAHAMAN BIRDS.

BY DR. JOHN I. NORTHROP.

(Abstract.)

After a few preliminary remarks upon the situation and size of the Bahamas, the speaker stated that a paper giving the details of the collection of birds would appear in the *Auk* for January. He stated that all the species, seventy-four in number, were represented by the specimens on the table, but that he would only call attention to the most interesting.

The following birds were then exhibited and remarked upon : *Miniocichla plumbea*, *Mimus polyglottis*, *Mimus Gundlachi*, *Polioptila cærulea cæsiogaster*, *Sciurus aurocapillus*, *Glothlypis rostrata* (a local form, slightly differing from the typical species found on New Providence), *Callichelidon cyaneoviridis*, *Doricha evelynæ*, *Sporadinus ricordi*, *Chordeiles minor*, *Icturus Northropi* (a new species of a genus not before reported from the Bahamas, and which has been described and named by Dr. J. A. Allen), *Cocyzus minor Maynardi*, *Saurothera Bahamensis*, *Phœnicopterus ruber* (the habits and mode of capture being described), *Nycti corax nycticorax nævius* (new to the Bahamas), *Rallus Coreyi*, *Ardea Bahamensis*, and several other water birds.

The speaker also mentioned finding in the stomach of *Autrostomus Carolinensis* an entire hummingbird sufficiently undigested to identify as *Sporadinus ricordi*.

He stated that the only mammals on Andros were bats, rats, and mice. The bat was *Macrotus Waterhousei*,[1] and the rat

[1] Kindly determined by Prof. J. A. Allen.

Mus rattus. The skin of the iguana, *Cychera bœolopha,* was exhibited, and the method of capture described. A few lizards were also shown, eight or nine species having been collected. The speaker had collected species of snakes, the largest of which, a species of boa-constrictor, was exhibited.

He briefly mentioned the large collection of invertebrates, and stated that, for the most part, it had not yet been worked up. One of the Anemones, however, is probably new. In this connection the speaker called attention to the interest connected with the geographical distribution of the Actiniaria, as Prof. McMurrich considered them to be related to Pacific forms.

In conclusion, Dr. Northrop mentioned the collection of plants, comprising about seven thousand specimens, and representing about six hundred to seven hundred species. These, he stated, were being worked up by Mrs. Northrop, and thirty or forty of the species were in all probability new.

The plants, as well as the birds, are decidedly Antillean in character and affinities.

At the close of the paper the meeting adjourned.

January 19th, 1891.

STATED MEETING.

VICE-PRESIDENT DR. HUBBARD in the chair.

About one hundred and fifty persons present.

The minutes of January 12th were read and approved.

The following resolutions were offered by DR. BOLTON, and unanimously adopted :

Whereas, CAPTAIN THOMAS L. CASEY, Corresponding Secretary of this Academy, and editor of the ANNALS, has himself borne the entire expenses of publishing the edition of Numbers 9, 10, 11, and 12, Vol. V., of the ANNALS (pages 307 to 504), said numbers containing his valuable contributions to Coleopterology ; therefore,

Resolved, That the thanks of the Academy are due, and are hereby offered, to CAPTAIN CASEY for his generosity ; also,

Resolved, That the name of CAPTAIN THOMAS L. CASEY be enrolled in the list of Patrons of the Academy ; and further

Resolved, That this preamble and these resolutions be entered on the minutes, and be communicated to CAPTAIN CASEY.

DR. HUBBARD introduced PROF. A. J. DUBOIS, of Yale University, New Haven, Conn., who delivered a lecture on the following subject:

SCIENCE AND MIRACLE.

At the close the Academy passed a vote of thanks to PROF. DUBOIS, and then adjourned.

January 26th, 1891.

STATED MEETING.

VICE-PRESIDENT DR. HUBBARD in the chair.

About forty persons present.

Minutes of January 19th were read and approved.

The following papers were read:

THE GEOGRAPHICAL DISTRIBUTION OF NORTH AMERICAN MAMMALS.

BY PROF. J. A. ALLEN.

(No abstract.)

THE ORIGIN OF THE AVEFAUNA OF THE BAHAMAS.

BY FRANK M. CHAPMAN.

(Abstract.)

The conclusions from this paper may be classified as follows:

1. The Bahamas are largely West Indian in their affinities, and the group of islands may claim the rank of a fauna of the Antillean region characterized by the prevalence of forms differentiated from their West Indian ancestors and by the infusion of a slight Floridian element.

2. A greater number of endemic species have been derived from Cuba than from any other region.

3. North American migrant species which breed in higher

latitudes, while occurring in the Bahamas in large numbers during certain seasons of the year, have not assisted in forming the resident avefauna.

4. The avefauna is of comparatively recent origin.

5. Forms of a common ancestor may be differentiated from this ancestor in much the same manner, and thus, though having widely separated habitats, more closely resemble each other than they do the parent species.

6. In several instances certain Bahaman forms inhabiting contiguous islands have become differentiated from each other without, so far as we can observe, being subjected to changed climatic or physiographic conditions.

7. We may perhaps assume from this that these birds originally owe their characters to individual variations which, among a limited number of individuals, have become permanent and specific.

February 2d, 1891.

Regular Business Meeting.

Vice-President Dr. Hubbard in the chair.

About thirty persons present.

The minutes of January 5th were read and approved.

The following recommendations of the Council (January 29th) were approved and the persons mentioned elected:

I. Payment of sundry bills amounting to $64.81.

II. The election of Dr. H. T. Vulté, of Columbia College, as a Fellow of the Academy, and Baron de Kroustchoff, Ph.D., M.D., of St. Petersburg, Russia, as Corresponding Member.

III. Accepting the resignation of Calvert Vaux.

IV. The nomination of Messrs. L. H. Jacoby, Emory McClintock, and John Tatlock, Jr., as Fellows of the Academy.

The proposed amendments of the By-Laws which were introduced January 5th were then taken up and discussed by chapter and section; with some further slight amendments they were unanimously adopted.

[*Note.*—A copy of such amended By-laws has been sent to each Resident Member and Fellow, and will appear in the TRANSACTIONS at the close of the current volume.]

GEORGE L. ENGLISH was proposed as a Resident Member by GEORGE F. KUNZ.

PROF. MARTIN announced the death of PROF. FELIPE POEY, of Havana, Cuba, a Corresponding Member of the Academy. The following is a brief sketch of his life:

Señor Poey was born in Havana in 1802. While a law student at Madrid he fled to Paris, being involved in some political conspiracy. After 1830 he returned to Havana, where he became professor of natural history in the University. He published accounts of more than 230 species of fishes before undescribed, and attained distinction in general literature. He has published "La Centurie des Lepidoptères" (1828), works on Cuba (1840, 1842), "Geografia Universal" (1842), and "Memorias sobre la Historia de la Isla de Cuba" (1864).

The following paper was read by title:

ON SOME NEW AND INTERESTING OCCURRENCES OF MINERALS AND PRECIOUS STONES IN THE UNITED STATES.

BY GEORGE F. KUNZ.

February 9th, 1891.

STATED MEETING.

About fifteen persons present.

In the absence of any of the regular officers, PROF. D. S. MARTIN was called to the chair.

The minutes of January 26th were read and approved.

PROF. MARTIN then read the following ticket for officers for the ensuing year, recommended by the COUNCIL February 6th, 1891:

NOMINATIONS OF OFFICERS FOR 1891–'92.

President, JOHN S. NEWBERRY.
First Vice-President, OLIVER P. HUBBARD.
Second Vice-President, J. A. ALLEN.
Corresponding Secretary, THOMAS L. CASEY.
Recording Secretary, H. CARRINGTON BOLTON.
Treasurer, HENRY DUDLEY.
Librarian, JOHN I. NORTHROP.
Councillors, N. L. BRITTON, CHARLES F. COX, A. A. JULIEN, D. S. MARTIN, J. K. REES, J. J. STEVENSON.
Curators, GEO. F. KUNZ, JOHN I. NORTHROP, N. L. BRITTON, D. S. MARTIN, H. T. VULTÉ.
Finance Committee, JOHN H. HINTON, H. G. MARQUAND, O. B. POTTER.

DR. A. R. LEDOUX exhibited specimens of petroleum oil occluded in quartz crystals from Marshall County, Ala.

The following paper was then read :

NOTES ON THE SWEET GRASS HILLS OF MONTANA AND THE KOOTENAI MINES OF BRITISH COLUMBIA.

BY ALBERT R. LEDOUX, M.S., PH.D.

(Abstract.)

It would be no evidence of ignorance if, in speaking of the Great Northern Railway, I should be asked, "Where is it?" for so quietly has the consolidation of the lines which make up this great system been effected that there are even railroad men to-day who would be unable to name the principal towns along its route; and yet its earnings during the month of January just past were $793,638. It is the creation of Mr. James J. Hill, of St. Paul, who conceived the bold idea of building a new line from the great lakes to the Pacific Ocean on a theory never heretofore attempted by any transcontinental line—that is, to build where the best grade was obtained, without consideration for local towns or local traffic, so that when completed it will form a link from ocean to ocean which will secure traffic because it

can be run at so moderate an expense compared with other lines. . . . And so the Great Northern is building, dividing the great territory between the Northern Pacific and Canadian Pacific roads, from St. Paul on the east to Fairhaven, on Puget Sound, on the west; and the surveys show a route not only the shortest by two hundred miles, but on which the average grade will be very much less than by any other transcontinental line, and the maximum grade about one-third of its most favorably situated competitor. . . .

The trip upon which I made the observations that I am to outline this evening was taken with a view of examining and reporting upon the resources of the country through which the Great Northern is to run, and I have selected two points which are of geological as well as economic interest for this evening's talk.

All along the main line, from St. Paul to Great Falls, towns and ranches and herders' corrals are springing up with the usual Western push and promise, Great Falls itself being the most conspicuous example. Six years ago there were a dozen houses at this point, scattered along the banks of the Missouri, and perhaps the most stupendous and available water power on the continent was only looked upon as one of nature's curiosities. Land was worth two dollars an acre. To-day there is a city of about five thousand inhabitants, with electric railway, electric lights, sewers, good hotels, five banks, and all the elements of a commercial centre. Over a million dollars are being expended in the erection of great smelting establishments, and a dam costing nearly a quarter of a million of dollars has been built to furnish a great water power for other manufacturing industries in process of development.

Within about two miles of old Fort Assinniboine, the new line now building to the coast leaves the Great Falls branch and starts westward. About eighty miles northwest of Assinniboine are the Sweet Grass Hills, serving as the source of the Sage and Cottonwood creeks, and surrounded on three sides by the Milk River—the latter a considerable stream, which, rising in American territory, flows north into the British possessions, and, after running some two hundred miles parallel with the border, returns to United States territory just east of the Sweet Grass country.

On our maps the Sweet Grass Hills are represented as a range running east and west just south of the Canadian boundary, and as they are approached from the direction of Assinniboine this view seems to be justified; but on a nearer view they subdivide into three separate buttes, distant about thirty miles from the Great Northern extension, and locally known as the North, Mid-

dle, and South buttes, the two latter being striking in appearance, forming steep, rugged cones, while the North Butte is somewhat less precipitous and covers more ground. Leaving the railroad survey at a point three thousand feet above the sea level, the prairie rises gradually some nine hundred feet in thirty miles. There are no signs of civilized life in this whole district, excepting that as the hills are approached there are remains of a Government corral, suggestive of Indian days, and the homes of one or two settlers upon the head waters of the creeks appear.

The prairie is strewn with glacial drift bowlders—apparently of quite recent deposition, as they are so little embedded in the soil—with sharp angles and edges, consisting of porphyry and syenite. There are no rocks in place, save here and there where streams have cut into the prairie; these are soft, calcareous and clay sandstones and shales, evidently very late Cretaceous or Tertiary. Upon reaching the most easterly butte it is seen to be divided into several peaks, the most southerly and most prominent being called locally "Mt. Morris." Approaching this mountain the ground is thickly strewn with every kind of igneous rock—dark green basalts, phonolite, and every variety of feldspathic porphyry. The summit of Mt. Morris I found by observation to be six thousand three hundred feet above sea level and two thousand four hundred feet above the old Government stockade. The mountain mass, like that of the two other buttes, is a grayish porphyry containing small feldspar crystals, but gashed and seamed by dike after dike of trap and large crystal birdseye porphyry. Between these dikes are older clay slates, mica schists, hornblendic schists, all inclined at a sharp angle against the mountain, and indicating clearly the intrusive character of the mass.

The quartzite carries free gold in considerable quantity, and where crossed by mountain streams some very rich pay gravel is found, which, owing to the scarcity of water, can hardly become available; but I was informed that miners have carried it down the hill and washed it in the Cottonwood with profit. The decomposed and altered slates also gave evidence of gold, but no development had been instituted. Here and there along the hillside were float masses of manganese and bowlders of magnetic iron, but the most remarkable and interesting feature, geologically, is a collar of limestone surrounding the mountain about two-thirds of the way up. This limestone belt is nowhere wider than seven hundred or eight hundred feet, but forms a complete circle, excepting upon the southern slope, where it is either broken or its continuity concealed by the talus from the porphyry cliffs above. It is highly metamor-

phosed in places, is tilted up at a sharp angle, and shows every variety, from gray and blue to a fine white statuary marble quite equal to the Carara. Near the summit of Mt. Morris I found a vein of quartzite running northeast and southwest, showing evidence of galena and stringers of gray copper, but without any development worthy of mention.

From the summit of Mt. Morris the other peaks which together form the mass of the East Butte are observed, being named respectively Mounts Lebanon, Brown, and Royal. Descending Mt. Morris toward the west and north, the limestone collar is soon reached and was followed by me to the north and east.

At the contact between the marble and porphyry on the north side occurs an interesting deposit of magnetic iron ore, showing, where decomposed at the surface, copper stains, and carrying traces of copper at certain spots. The outcrop is from forty to fifty feet in width, and extends for seven hundred or eight hundred feet in the arc of a circle, following the limestone contact, and has been prospected in a number of points by shafts, tunnels, and cross-cuts, indicating a probable permanency to a considerable depth. At one point a shaft fifty-four feet deep was all in ore, with a cut extending southward for forty feet, all in solid magnetite, without, as yet, going through it. This ore yields sixty per cent of iron by assay and is low in phosphorus. Its location, however, renders it of little value for many years to come. From the fact that magnetic bowlders were noticed by me on the north side of the mountain and also on the eastern slope, I am ready to believe that this iron-ore bed may be found to extend for several thousand feet further than it has been explored as yet.

I had no opportunity to examine the other peaks of the East Butte, nor to ascend either the Middle or West Butte, but was informed by an intelligent miner, that they consisted of porphyry similar to Mt. Morris, with the same dikes of trap, and with indications of copper, lead, and gold, but practically unprospected.

The line of the Great Northern running westward from Assinniboine will cross the famous Flathead country between the main range and the Bitter Root range of the Rockies, overcoming the former through the Marias Pass. This Flathead country promises remarkable developments in coal, iron, and other metals, but is at present almost unexplored, excepting around the lake and reservation, and is a paradise for the lover of big game. Then turning northward, the line will strike the Kootenai River at the point where from its southern flow it

abruptly turns northward, and will run parallel to the river to a point about eight miles from Bonner's Ferry.

At present this most interesting Kootenai region is best reached by the Northern Pacific line to Kootenai Station, about thirty miles east of Spokane Falls, whence a stage ride of thirty-three miles brings one to Bonner's Ferry.

The natural commercial outlet of Kootenai Lake is southward into the United States, and the Northern Pacific has already made several surveys from their line to Bonner's Ferry, which is at present the head of navigation on the Kootenai River; but it is hardly likely that this line will be built, since the Great Northern will be running to within eight miles of this point next year.

The Kootenai River is navigable for one hundred and twenty miles above the lake to Bonner's Ferry, and is singularly free from shoals, bars, or similar impediments. It is a sluggish, very winding stream, from two hundred to five hundred feet in width, flowing through rich bottoms which grow hay, grain, and potatoes in the greatest luxuriance, but which are liable to overflow when the river is swollen by the melting snows of the spring.

Kootenai Lake is ninety miles long and of unknown depth; soundings are said to have been made at points to a depth of fifteen hundred feet without finding bottom. This is quite likely from its situation, as it lies between two of the ranges of the Selkirks, which are quite precipitous at these points and slope directly into the water. Indeed, it is not possible at high water to walk for any considerable distance along the shore, as the rocks come perpendicularly into the water at many points. Kootenai Lake never freezes, but navigation on the river is interrupted for about three months in the winter by ice; although it is said that a strong boat could readily keep the stream open during the whole season, at least as far south as the boundary.

The mountains of the Selkirk range consist of a hard gray granite, their peaks rising from five thousand to nine thousand feet above the sea. The mountains in the immediate vicinity of the lake are not higher than six thousand feet, but beyond and to the north, on a clear day, a wilderness of summits rising one above another is visible, snow-capped and glacier-covered. The Canadian Geological Survey have published a special bulletin on the geology of this region, based on a visit in 1889, and the data then obtained have convinced Dr. Dawson that the lake occupies a depression largely formed by the wearing away of the more recent stratified rocks, which are still

observed, though highly metamorphosed, on the shores and mountain-sides. My own observations confirm this belief, and I would add that these stratified or metamorphic rocks are not horizontally imposed upon the granites, but their plane of present position is inclined at an angle of perhaps forty-five degrees with the horizon. On the eastern shore of the lake the mica schists, shales, and crystalline limestone are to be found cropping out—coming to a thin edge—at a point not over a mile distant from the lake, and at an elevation of not more than two hundred or three hundred feet, above which nothing but granite occurs; while on the western shore these stratified beds are found extending nearly to the summit of the range, at an elevation of five thousand feet, and distant, on the incline, several thousand feet from the water's edge.

It is unnecessary to speak of the geology of the district any further, or to repeat Professor Dawson's careful observations which are noted in his report; but I will proceed at once to the mineral resources, an examination of which was the object of my visit to Kootenai.

Mineral development is but just entering upon its earliest stages in the district, and yet, for the short time since exploration was commenced, a great deal has been done. On the westerly side of the lake is the Warm Springs Camp, so named from a warm calcareous spring which flows out on the lakeside in characteristic pools, basins, and terraces, the water of which is said to be beneficial in some forms of skin diseases. I ascended the mountain above the town of Warm Springs, to a height of five thousand three hundred feet above sea level, by one trail, and descended by another some miles to the southward, taking in *en route* some of the principal prospects. There are apparently five parallel ledges running north and south, some of them in a crystalline limestone, others in the granite and altered schists, and still others at the westerly contact between the limestone and the granite. These lodes are located upon for two or three miles north and the same distance south of Warm Springs, and apparently vary from six hundred feet to one-half mile apart.

There are more than three hundred locations filed in the district. The ore is principally galena, with more or less native silver, some brittle silver, and a little sulphide of copper. Through the courtesy of the officials I was permitted to make an extract of the returns of ores shipped out during the summer of 1889: one hundred and forty-six tons assaying eighty-seven ounces of silver; eighty-five tons, ninety ounces; seventy tons, two hundred and thirty ounces; sixty-five tons, forty ounces; twenty tons, one hundred and twenty ounces; fifteen tons, two hundred and

twenty-five ounces; fifteen tons, one hundred and nineteen ounces; and twelve tons, ninety-five ounces. The lead varied from twenty to seventy per cent. During 1890 considerable more was shipped.

The deepest mine in the camp is only one hundred and thirty-two feet deep, and, as all the ore has to be packed down at present, and the expenses of getting to smelters in the absence of railway transportation are so great, it is being piled up at the mines, awaiting further development.

Ascending the mountain, I first examined the "Jeff Davis" claim, which is about seven hundred feet above the level of the lake. The vein is quite well defined, showing eighteen inches of ore in mica schist. The pure galena carries about twenty ounces of silver to the ton. This vein is in the first lode from the lake, at a height of about eleven hundred feet above it. In the second lode is the "Spokane," showing a twenty-six inch vein of galena in mica schist, the pure galena carrying about forty ounces of silver to the ton. The gangue is quartz, and a considerable amount of iron pyrites is visible, but only a few feet of shaft have been sunk on the vein. On this same lode are several extensions more or less developed. Following up this trail, I next came to the "Sunlight," at an elevation of nineteen hundred feet, and in the third of the main lodes. This is in the limestone, and shows considerable development, the ore being more or less oxidized, the mineral body being twenty inches in diameter, uncovered for some distance, and the clear galena assaying sixty ounces of silver.

There are several more claims on this lode, with more or less development. In the fourth lode I next looked at the "No. 1," at an elevation of twenty-five hundred feet above the lake. Considerable work has been done. The ore body is large, selected samples showing one hundred and fifty-seven ounces of silver to the ton. The mineral, partly carbonate, partly galena, occurs in grayish limestone and is uncovered for several hundred feet. The ore is very friable and decomposed at the surface, but sulphurets and wire silver are found at depth.

There are a number of other locations on this lode, but I did not visit them. The highest claim is the "Sky Line," situated southwest of, and over a mile from, the last, at an elevation of nearly five thousand three hundred feet above sea level. It is being actively and liberally developed, the vein being fourteen feet wide and the ore showing considerable wire silver. Near the surface it is very much altered and decomposed, but at depth considerable galena is obtained. This ore is being packed to the lake, and shipments of several carloads of selected material have yielded three hundred ounces of silver.

Descending by the southern trail, I passed a number of mines in active operation, such as the "Little Donald," on the same lode as the "Spokane"; the "Krao," showing considerable ore body and a promising galena said to assay ninety ounces of silver. This mine is at an altitude of four hundred feet. Above this was the "United," showing coarsely crystalline galena rich in silver.

This will serve to indicate the general features and prospects of the Hot Springs Camp. Unquestionably there is a great deal of ore, and a large supply can be depended upon from this camp, in spite of the fact that no one claim has as yet been worked to such a depth that any certain conclusions can be drawn as to the permanency of the deposits.

It may be said in general that the ores in the limestone are dry and very rich, though perhaps uncertain in extent, as is usually the case. Whether any of the veins in the schists and granite are true fissures it is perhaps impossible to say at this stage of the development. Most of these mines will become concentrating propositions, and furnish a large amount of silver as well as lead.

Across the lake from the Warm Springs, a headland juts out nearly a mile beyond the ordinary shore line, bounded by bays at the north and south. Looking at this headland from across the lake, it may be described as consisting of two hills, the northernmost perhaps two hundred and twenty-five feet above the lake level, and the southernmost one hundred feet higher, divided by a valley sloping to the lake shore. Upon this promontory are situated the Hendryx group of mines, consisting of the "Blue Bell," "Silver King," "Fraction," etc. The rocks of the peninsula are principally mica schists, with occasional dikes of trap and highly metamorphosed limestone. Parallel with the lake, and running north and south through the entire peninsula, is a very large vein of sulphurets, varying from ten to twelve feet on the "Kootenai Chief," where it emerges from the lake on the south, to the width of over eighty feet on the "Blue Bell" claim, when it again narrows and disappears in the lake on the north in the "Comfort" location.

This vein is strong and persistent for over three thousand feet, showing again and again on the surface of the ground, in places carrying galena, but principally made up of iron pyrites, zinc blende with a little copper, etc.

Upon none of these claims, excepting the central ones, owned by the Kootenai Mining and Smelting Co., has there been any serious development work, but the latter have been thoroughly prospected in a way to open out a great body of lead ore, with

undoubted promise of making this camp one of the principal producers of lead in British Columbia, if not on the continent. . . . The greatest masses of galena are contained in offshoots from this main vein on the easterly side, and are of great importance and value.

The surface indications on the vein proper for galena are, as stated, not very numerous, but the moment it is crossed on the Hendryx claims the ground is found to be strewn with masses of carbonate, or galena more or less oxidized, and upon these chutes there are pits and openings which reveal their extent.

This galena property has been developed by a tunnel some eight hundred feet long at an angle with the strike of the ore body, which cuts, in its course, first about two hundred feet of quartzite and mica schist, then a dike of porphyry six feet wide, then forty-five feet of quartzite, then thirty feet of marble, then seventy feet of sulphurets, and then alternations of limestone and galena ore, over seventy feet of the latter being exposed at one point, on which an upraise to the surface two hundred and fifty feet above has been made, with drifts at the one hundred and two hundred foot levels, showing large bodies of ore.

It is safe to predict that this property, when an outlet is made into the United States by railroad connection, and, above all, when reciprocity with our northern neighbors becomes an established fact, will form the basis of a large and profitable smelting operation. The galena in this mine is low in silver, while that of the average ore across the lake is quite high. One peculiarity, by the way, of this district, which was new to me in my experience, was finding *coarse-grained* galena carrying considerable silver, and the fine-grained galena comparatively poor in silver. This is a reversal of the conditions usually found in lead-silver ores.

Tributary to the Kootenai Lake are already springing up numerous promising mineral localities. The various creeks and streams flowing into the lake bring down gold-bearing float, and even coal, after freshets, has been found on the shores of upper Kootenai. At Nelson and Toad Mountain are promising copper camps, while from Goat River prospectors are bringing very handsome specimens of copper sulphurets. The Toad Mountain copper ore especially is high in silver.

Development has practically but just commenced in this section of British Columbia, and it is reasonably certain that the great masses of the Selkirks in the area now practically unexplored, between the head of Kootenai Lake and the Canadian Pacific Railroad, will yield considerable mineral. At any rate, if the political horizon does not deceive us, the smelters of Mon-

tana and Colorado may soon look to a supply of lead ore from Kootenai in the shape of concentrates, of which they have been, to their great loss, deprived by the exclusion of Mexican sulphurets by our tariff.

The following papers were then read:

THE PRECIPITATION OF SUSPENDED SILT AND CLAY IN RIVER WATERS

and

THE DISCOVERY OF A STARCH-DIGESTING FERMENT IN COW'S MILK, AND ITS RELATION TO NUTRITION.

BY PROF. A. R. LEEDS.

(No Abstracts.)

February 16th, 1891.

STATED MEETING.

VICE-PRESIDENT DR. HUBBARD in the chair.

About one hundred persons present.

The minutes of February 9th were read and approved.

The fourth lecture of the Public Course was delivered by PROF. WALLACE GOOLD LEVISON, of Brooklyn, N. Y., entitled

INSTANTANEOUS PHOTOGRAPHY AS AN AID TO SCIENCE, HISTORY, AND ART.

Illustrated by a large number of novel lantern views.

At the close of the lecture a vote of thanks was offered to the lecturer.

February 23d, 1891.

ANNUAL MEETING.

VICE-PRESIDENT DR. HUBBARD in the chair.

About twenty-five persons present.

The minutes of February 16th were read and approved.

The report of the COUNCIL was read, recommending the formation of a Section in Astronomy. In accordance with this report the following resolution was adopted:

Resolved, That the recommendation of the COUNCIL for the formation of a Section of Astronomy in the New York Academy of Sciences be approved.

REPORT OF THE RECORDING SECRETARY FOR THE YEAR ENDING FEBRUARY 23D, 1891.

NEW YORK, February 23d, 1891.

There have been 12 meetings of the COUNCIL, 38 meetings of the Academy (including 9 public lectures), and 4 joint meetings.

Thirty-one formal or announced papers have been read as follows, on

Mineralogy	8
Geology	4
Chemistry	4
Zoölogy	4
Ethnology	5
Archæology	2
Engineering	2
Miscellaneous	2

Besides nine papers read by title and a number of informal communications on a variety of topics.

The average attendance at meetings, exclusive of public lectures, is 20.

There are 239 Resident Members, including 66 Fellows.

During the past year the Academy has elected

14 Resident Members,
11 Corresponding Members,
1 Honorary Member,
2 Fellows.

Fifteen members were lost by death, resignation, etc.

Submitted by

H. CARRINGTON BOLTON,
Recording Secretary.

Approved February 23d, 1891.

The New York Academy of Sciences in Account with Henry Dudley, Treasurer.

February 24th, 1890, to February 23d, 1891.

DISBURSEMENTS.

Dr.	For printing Annals and Transactions	$1,551 33	
	" paper and addressing same	13 25	
			$1,564 58
	" Publication Committee		42 72
	" D. S. Martin, salary as Editor		200 00
	" H. T. Vulté, salary as Assistant Rec. Sec'y		300 00
	" express, paper, postage, freight, etc		198 85
	" printing letter heads, envelopes, receipts, and postals		127 85
	" lecture expenses		45 00
	" binding publications		132 05
	" engravings, electrotypes		18 00
	" insurance		20 00
	" janitorial services		107 75
	" deposit in Library Fund	$100 00	
	" " " General "	80 00	
			180 00
	Balance in Second National Bank		314 38
	Total,		$3,251 18

RECEIPTS.

Cr.	By Balance February 24th, 1890		$856 96
	" life membership fee		100 00
	" membership fees		140 00
	" sale of Annals and Transactions		45 22
	" U. S. 4 per cent, regular interest	152 00	
	" " " " coupon "	12 00	
			164 00
	" gift from Captain T. L. Casey		80 00
	" annual dues		1,865 00
	Total,		$3,251 18

SECURITIES ON HAND.

U. S. Gov't 4 per cent consols, regular	$3,800	00
" " " " " coupons	300	00
Savings bank accounts:—		
General fund	1,006	97
Publication fund	782	03
	$5,889	00

HENRY DUDLEY, *Treasurer.*

February 23d, 1891.

March 14th, 1891.—I hereby certify that I have this day examined the vouchers and securities of HENRY DUDLEY, Esq., Treasurer of the New York Academy of Sciences, and find them correct. JOHN H. HINTON, M.D., *Chairman Audit. Com.*

REPORT OF THE AUDUBON MONUMENT COMMITTEE.

The Committee appointed to procure funds for the erection of a suitable monument to John James Audubon over his grave in Trinity Cemetery, would report that other pressing duties made it necessary for the members of the Committee to temporarily suspend active operations during the first part of the year. Recently appeals for subscriptions have again been made, with a gratifying result, nearly $1,000 having been paid over to the Treasurer during the last six months.

The financial situation may be stated as follows:—

Money received from all sources to date	$2,088 76
Expenses of the Committee to date	270 26
Balance on hand	$1,818 50
Subscriptions conditional on $10,000 being raised for the monument	$1,400 00
Total amount subscribed to date	$3,218 50

The Committee would respectfully request to be continued.

For the Committee,

N. L. BRITTON,
Secretary and Treasurer.

The CORRESPONDING SECRETARY made a verbal report, which was approved.

The Chairman of the PUBLICATION COMMITTEE and the LIBRARIAN presented no reports.

Messrs. CASEY and BRITTON were appointed tellers for the Annual Election. After the casting of the ballots they reported that the following ticket was elected:—

OFFICERS FOR 1891–'92.

President, JOHN S. NEWBERRY.
First Vice-President, OLIVER P. HUBBARD.
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Finance Committee, JOHN H. HINTON, H. G. MARQUAND, O. B. POTTER.

PROF. MARTIN announced the death of PHILIP A. WHITE, a Resident Member, and PROF. ALEXANDER WINCHELL, a Corresponding Member. MR. GARRETTSON spoke of PROF. WINCHELL as a classmate and life-long friend.

A letter from J. FRANCIS WILLIAMS was read by the Secretary, announcing the discovery of a new mineral monticellite, containing perhaps some alumina as a replacement of the iron. The foci are given as ∞P, $\breve{\infty}P\breve{2}$, $\infty P\bar{\infty}$, $P\infty$, $P\,P\bar{\infty}$. The $\infty P\bar{\infty}$ is extremely large as compared with most species of monticellite, and gives the crystals the appearance of being of equal dimensions in all directions at right angles to the vertical axis. It is also columnar, and the fundamental prism ∞P is more decidedly developed than the $\infty P\breve{2}$ foci. The crystals have somewhat the appearance of monazite crystals, with this exception.

Prof. Allen announced that a new species of thrush had been discovered in Dominica, an island of the Lesser Antilles.

The following paper was read, entitled

RECENT WORK IN NORTH AMERICAN MAMMALOGY.

BY J. A. ALLEN, PH.D.

(Abstract.)

The present review of recent progress in North American mammalogy relates especially to the period since the appearance of Baird's great work on the mammals of North America, published in 1857, forming Volume VIII. of the Government Reports on Explorations and Surveys for a Railroad Route from the Mississippi River to the Pacific Ocean, made during the years 1853–56. While that work is taken as the basis of departure, it is of interest to note briefly some of the more important of the earlier works relating to North American mammals.

A review of the history of North American natural history necessarily begins with Catesby, whose great work, "The Natural History of Carolina, Florida," etc. (two volumes folio), was published in parts from 1730 to 1748. In this were figured and described for the first time a number of our mammals.

Pennant's "Arctic Zoölogy" (three volumes quarto, 1784–87) includes notices of many North American species.

Besides numerous more or less important incidental contributions made by explorers and travellers, and the descriptions of new species based on specimens collected by Lewis and Clarke in the years 1804–6, and by Major Long in 1819–20, and by various arctic explorers, as Sabine, Scoresby, and Richardson, there is little to note till we reach the year 1825, when Richard Harlan published his "Fauna Americana," an octavo volume of about 300 pages, devoted exclusively to North American mammals. It is now mainly of interest as the first general treatise on the subject, although for its time a creditable production. He described 127 species as "inhabiting North America north of Mexico." Of this number 11 were based on the fossil remains of extinct species, reducing the number of living species to 116.

This work was soon followed by a much more extended and elaborate general treatise by John D. Godman, published under the title "American Natural History: Part I., Mastology," an octavo work in three volumes, the first two published in 1826, the third in 1828. The work was illustrated with numerous plates engraved on copper, giving very good figures of nearly

all the species. For the date of publication the work is one of high merit and may yet be consulted with much profit.

In 1829 appeared an exceedingly important work on North American mammals, namely, the first volume of Richardson's "Fauna Boreali-Americana," a quarto of 300 pages and 24 plates, on the mammals of British North America. It is still a standard work, and is the chief source of information on the habits and distribution of the mammals of the region north of the United States.

Among later important works of a general or faunal character may be mentioned Emmons' "Report on the Quadrupeds of Massachusetts," published in 1840; and DeKay's "Report on the Mammals of the State of New York," a quarto volume with thirty-three colored plates, published in 1842. This work includes references to all of the then known species of North American mammals, and served for many years as a general reference work, though it failed to take very high rank as an authority. Linsley's list of the mammals of Connecticut[1] was published in 1842; Thompson published a valuable fully annotated list of the mammals of Vermont[2] in 1853; and Kennicott published an important paper on the mammals of Illinois in 1857.[3]

The great work of Audubon and Bachman, entitled "The Viviparous Quadrupeds of North America," published in three volumes, royal octavo, 1846–54, with colored plates, marks a new era in North American mammalogy. About 200 species are described and 160 figured. The work, however, does not include either the bats or the marine species. It is devoted especially to the life histories of the mammals, and deals only to a limited extent with technical matters. Strange as it may seem, this forms the latest general work on North American mammals which treats of the subject from its popular or non-technical side, although one or two later works treat certain groups from a general standpoint, dealing with both the popular and the systematic phases of the subject. Audubon drew most of the plates of the great work with which his name is associated, and jointly with Bachman contributed largely to the text; but the strictly systematic portion is well known to be the work of Bachman, the father of systematic mammalogy in America, and, prior to Baird, the leading authority on the subject. His monographic revision of the genera *Sorex*, *Scalops*, *Sciurus*, and *Lepus*, form-

[1] American Journal of Science and Arts, XLIII., 1842, pp. 345–354.

[2] Natural History of Vermont, 1853, Mammals, pp. 23–56, and App. pp. 11–20.

[3] Report Commissioner of Patents, Agriculture, 1856, pp. 52–110, pll. v.–xiv.

ing a series of special papers published 1837–42, were contributions of the highest importance, and the first careful, systematic work on any special groups of American mammals by an American writer.

Incidentally important contributions had been made by numerous foreign authors, but it would carry us far beyond our present scope to consider them in detail.

Baird began to write on North American mammals as early as 1852, his work culminating in 1857 in his great work already mentioned—a work which gave him pre-eminent standing as an authority, and which still remains the basis from which present investigators take their departure.

Baird's volume included only the land mammals, exclusive of the bats, which, with the seals and Cetacea, were not treated. With these several groups omitted, Baird recognized about 220 species as entitled to a place in the list of North American mammals,—nearly twice the number given by Harlan in 1825. Thirty-six others are mentioned as having been attributed to North America, which he was unable to recognize. A few of these are extralimital, but the greater part are either purely nominal, or so poorly described as to render their recognition impossible.

Baird treated the subject exclusively from the systematic side, there being nothing in his work relating to the habits of the species. Classification, and all questions of synonymy and nomenclature, were treated exhaustively; specific and generic characters were presented in detail and with great discrimination. As a technical treatise the work remains a monument to the industry and sagacity of its talented author, and, considering its extended scope, has not been excelled by any work, in any country, on systematic mammalogy. It was illustrated by sixty lithographic plates and nearly forty woodcuts, relating mainly to cranial, dental, and other structural characters. In 1860 the text was reissued, with a large number of additional plates, some of them new, but mostly from other volumes of the Pacific Railroad and Mexican Boundary Survey reports.

Professor Baird brought to his work not only a mind well trained in modern methods of research, but he was favored with resources in the way of material far beyond what had fallen to the lot of any of his predecessors.

In March, 1853, Congress appropriated $150,000 for the prosecution of surveys by the War Department of various routes across the continent, from the Mississippi River to the Pacific coast, for the purpose of determining practicable lines for the construction of railroads. Six well-equipped parties were placed at once in the field, and six others were soon added, each accom-

panied by a competent naturalist. Large collections were at the same time made by other officers of the army stationed at various posts throughout the distant West, and also by the United States and Mexican Boundary Survey. Although the collections made by the Boundary Survey were made the subject of a special report, they formed also a part of the material on which was based Baird's memorable "Eighth Volume," as this work is familiarly known among mammalogists. These collections were, by act of Congress, all transmitted to the Smithsonian Institution, and were thus brought together as a single collection, to be elaborated, fortunately, by one of the most competent naturalists America has yet produced.

But the volume under notice was not the sole outcome of these various Government surveys. Other volumes of the Pacific Railroad Reports contain the special field reports of the various naturalists of the different routes surveyed, accompanied by numerous plates of new or previously unfigured species. These reports embody the field notes of the collectors, and thus admirably supplement with biographical matter Baird's exhaustive systematic treatise. Hence to Gambel, Woodhouse, Kennerly, Cooper, Gibbs, Suckley, Heermann, Newberry, Trowbridge, and Gunnison—names well ingrained in the literature of many departments of North American natural history—we are deeply indebted for much of our information respecting the habits and distribution of the mammals of Western North America.

Since the publication of Professor Baird's great work in 1857, several monographs have appeared treating of particular orders or families. In 1864 the Smithsonian Institution published Dr. Harrison Allen's "Monograph of the Bats of North America," an octavo of about 100 pages, illustrated with numerous woodcuts. This was the first general systematic treatise on North American bats since the works of Godman and Harlan, published nearly forty years before, and it remains still our standard work on this group, and the only special treatise on the North American species of the order. Twenty species are recognized, and many others referred to as unidentifiable.

In 1866 Dr. Theodore N. Gill published a "Prodrome of a Monograph of the Pinnipedes," giving a systematic synopsis of the families, genera, and species of the marine Carnivora—the seals and their allies.

In 1870 I published a monograph of the family Otariidæ, or Eared Seals,[1] a paper of 108 pages, with three plates and a number of woodcuts, giving a detailed account of their osteology and

[1] Bull. Mus. Comp. Zoöl., II., No. 1, 1870, pp. 1–108, pll. i.–iii.

external characters, supplemented by an extended account of their habits by Capt. Charles Bryant, formerly a Government agent at the Fur Seal Islands. Later very elaborate reports by Mr. Henry W. Elliott, on the habits of the species, have been published by the Treasury Department of the Government.

In 1874 appeared Capt. C. M. Scammon's work, "The Marine Mammals of the Northwestern Coast of North America, described and illustrated, together with an account of the American Whale-Fishery," a quarto volume of about 325 pages and 27 lithographic plates. The appearance of this work marked an era in the history of our marine mammalia, though restricted to those of the Pacific coast. It covered a new field, and furnished an inexhaustible fund of information, to which we are still almost wholly limited, as far as the life histories of the species are concerned. Cope, Gill, and Dall have contributed also various important papers on the Cetacea, treating the subject from the systematic side, and largely relating to the species of the Pacific coast.

More recently Mr. F. W. True, Curator of Mammals in the United States National Museum, has entered the field, and, besides numerous minor papers on various species of the Atlantic coast, has recently published "A Review of the Family Delphinidæ," an octavo memoir of 200 pages, with 47 plates. This is a monograph of the porpoises and dolphins of the world, and is a most welcome and able contribution to the subject. Sixty-two species are described, and nearly all are figured.

J. D. Caton has published numerous papers on our deer, and in 1877 an octavo volume of nearly 500 pages, with numerous woodcuts, entitled "The Antelope and Deer of America." It deals principally with their habits, affinities, and susceptibility to domestication, and is in its way an excellent treatise, and the only one relating exclusively to these animals.

Our most important ruminant, the American bison, was monographed by myself in 1876 in a quarto memoir of about 260 pages and 12 plates. Mr. Hornaday, in an octavo paper of nearly 200 pages, with many illustrations, entitled "The Extermination of the American Bison," published in 1889, has admirably brought the subject down to date.

In 1877 Dr. Coues published his "Fur-Bearing Animals: a Monograph of North American Mustelidæ." It is an octavo of about 350 pages and 20 plates, and forms a most important contribution to the literature of North American mammals.

In 1877, also, Dr. Coues and myself published a series of monographs of the various families of North American rodents, forming a quarto volume of 1,100 pages, entitled "Monographs

of North American Rodentia." While the two authors shared the labor about equally, the joint authorship implied in the title relates merely to the fact that their separate memoirs are bound together under one general title, the different monographs being each by a single author. The work consists of eleven separate and distinct memoirs. In two cases, as in the monographs of the squirrels and hares, the scope is greater than is indicated by the general title of the work, all of the species found in Mexico, South and Central America, being included, as well as those from North America. An important feature of this work is the bibliographical appendix, by Gill and Coues, consisting of about 130 pages, and bringing the bibliography of North American mammals down to the year 1874, in a very thorough manner, and including most of the titles down to as late as 1876.[1]

In 1880 I published an octavo volume of about 800 pages, with numerous illustrations in the text, entitled "History of North American Pinnipeds: a Monograph of the Walruses, Sea-Lions, Sea-Bears, and Seals of North America," treating the subject at length in all its bearings.

In addition to the special works already enumerated, numberless papers, some of them of great importance, have appeared in Government reports and in the transactions of scientific societies. Some of these are simply more or less fully annotated faunal lists; others are faunal lists, including incidentally much technical matter; others are more or less elaborate monographs of particular genera or families; others still are brief papers describing new species or recording rare ones. Baird published practically nothing on mammals after 1859, since which time the most prominent names in the field have been Harrison Allen, J. A. Allen, Caton, Cooper, Cope, Coues, Dall, Gill, Kennicott, Mearns, Merriam, Scammon, and True.

Besides these, Alston, of England, has published on the mammals of Mexico, in Godman and Salvin's "Biologia Centrali-Americana"; De Saussure has also written important papers on the same subject; while Brown and Ross have published valuable memoirs on the mammals of Arctic America.

[1] The titles of works and papers briefly mentioned in the present paper will be found there given in full. The intended scope of the work was to include "(*a*) all works and papers on mammalia at large published in North America, (*b*) all works and papers, wherever published, relating to North American mammals, and (*c*) such general works or collateral special papers as bear more or less directly upon the subject." The titles are arranged chronologically under a few general heads. Though not put forth as absolutely complete, it still remains the most extended compilation on the subject yet published.

Two orders of our mammals have received very little attention for nearly thirty years, and in respect to them we are at present entirely at sea as regards the number of species, their relationships, or their correct names. These are the bats, which have not been monographed since 1864, and the moles and shrews, which have not been thoroughly revised since 1857.[1] We are happy to say, however, in respect to the former, that Dr. Harrison Allen has a work in press, under the auspices of the Smithsonian Institution, relating to the bats, which will give us a new and most welcome point of departure for this group. The outlook regarding the moles and shrews is less encouraging, there being unfortunately no similar work under way treating of these groups from the American standpoint. Some years since, however, Dr. Dobson, of England, undertook a monographic revision of the Insectivora of the world, but the third and last part, which is to treat of the shrews, has not yet appeared. In 1874 this same author published a monograph of the bats of the world, including, of course, North American. This work was a boon to workers in this field, and a great help respecting our own bats, though not altogether satisfactory.

We have now said all that our limited time will permit concerning the progress of North American mammalogy from the bibliographic standpoint; its progress from the scientific standpoint remains to be considered.

Prior to the Government explorations which yielded the material on which Baird's work was based, we had only the most superficial knowledge of the mammalogy of North America at large, or beyond the more settled parts of the eastern portion of the United States. No museum, public or private, had a good series of specimens of even our most common mammals. Species without number had been described, generally in the most imperfect manner, from either single or comparatively few specimens, and the types had been preserved only in rare instances. Almost nothing was known of either seasonal or individual variation, nor was the material extant for the study of either of these very important phases of the subject. Even Professor Baird, in working up his comparatively abundant material from the West, found himself often baffled in his comparisons by the absence of specimens from the East. Pro-

[1] In 1877 Coues published an important preliminary paper on the North American Insectivora, entitled "Precursory Notes on American Insectivorous Mammals, with Descriptions of New Species" (Bull. U. S. Geol. Surv., III., 1877, pp. 631-653). He intended to follow this with an elaborate monograph of the group, which, however, unfortunately was never completed.

fessor Baird was thus confronted at the beginning of his work with a chaos of names and meagre descriptions, the legacy of his predecessors. Even not a few of the species of Audubon and Bachman were based on specimens from unknown localities, not always correctly supposed to be North American. Leconte, DeKay, Say, Ord, Rafinesque, and Harlan, and various foreign authors, had each contributed to the list of nominal species, many of which will forever remain undeterminable, while others have been duly relegated to the limbos of synonymy. The work of separating the chaff from the wheat, the false from the true, was a perplexing task, an intricate riddle, which Baird attacked with wonderful acumen and success, leaving a comparatively smooth and easy path for his successors.

This was, however, the period of excessive subdivision, the smallest recognizable differences serving as the basis of specific separation. Baird, as was natural, influenced by the methods of his time, contributed his share to the list of synonyms; yet, considering the inadequateness of his material, his lapses were few, and more than atoned for by the accuracy and detail of his descriptions. If he failed to substantiate tangible differences between closely allied forms, it was because they did not exist, not from any lack of care in his work. Sometimes features of seasonal or individual variation were mistaken for specific difference, but, as a rule, any forms recognized by Baird as species will bear the closest scrutiny, and are rarely found to be without some basis in nature—that is, if not "good species," they will be found to be what we now call geographical forms, or "subspecies."

The history of North American mammalogy and the history of North American ornithology run in closely parallel lines, the prominent workers being practically the same in each. In both of these departments there have been periods of excessive splitting, followed by undue lumping. On a former occasion I have referred at length to "the oscillations of the ornithological pendulum" during the last thirty years.[1] In mammals, as in birds, a period of "lumping" set in about 1870, following a long period during which the tendency had been to excessive subdivision, and extending into the present decade. The period from 1870 to 1880 was thus not only a lumping period, but a transition period, and also one of unequalled activity. Work was carried on also from a basis in some respects the exact reverse from that of the immediately preceding epoch. While the outcome was on the whole a marked advance on what had preceded, it is obviously open to material revision as seen from the standpoint of

[1] The Auk, Vol. VII., Jan., 1890, pp. 1–9.

to-day. A third period, differing much from either of the two preceding, has now opened ; its culmination and final results cannot as yet be foreseen.

During the Bairdian period of North American mammalogy, the discovery of new forms was the paramount incentive to investigation. The method of study was hence intensely analytic ; differences, rather than resemblances, filled the mind of the investigator. At this period the subject of variation under climatic influences, the evolution of species by environment, had attracted little attention. But the facts of evolution were being minutely recorded ; a harvest was being reaped which was to form the basis of important generalizations, as then unsuspected even by the most industrious of the reapers. But they did their work well, and it is not to their discredit that they failed to see at first some of the fundamental principles of the evolution of life under the influences of environment. We have always first to gather our facts before we can generalize. Professor Baird himself, however, was the first to perceive and formulate some of the fundamental laws of geographical variation, as regards both North American birds and mammals, in the study of which, be it said to the credit of American naturalists, such principles were first recognized and established. Baird early perceived that, as a rule, individuals of the same species decreased in size from the north southward ; that the animals from the arid plains were paler in color than their nearest relatives of the wooded region to the eastward; and that over the heavy rainfall belt of the Northwest they assumed a depth of coloring met with nowhere else on the continent. He also recognized that, in some instances, the size of peripheral parts, especially in birds, increased in size from the north southward, while the general size of the individual decreased. Later it was also noticed that, as a rule, individuals of the same species became brighter colored at the southward as compared with their northern relatives—that black bars and streaks were broadened at the expense of the intervening lighter spaces ; that birds with metallic tints became more iridescent, and that the duller colors, of both birds and mammals, became deepened and intensified.[1]

In subsequent years, as material increased and large series of specimens of the same species and from the same locality were brought together, it was found that the range of purely individual variation, in respect to every feature, was far greater than had previously been suspected. This, of course, seemed to invalidate certain characters on which species had previously often

[1] See Allen, "Mammals and Winter Birds of East Florida," Bull. Mus. Comp. Zoöl., II., No. 3, 1871.

been based. Again, the increase of material from new localities showed that certain forms described as species gradually varied in the direction of other species, through specimens from intermediate points of the common habitat. In other words, we began to be troubled with a lot of specimens that were variously intermediate between two or more previously supposed wholly distinct species. This occurred not merely in a few isolated cases, but frequently over most of the continent. Under these circumstances, and in the light already thrown upon the general subject, it was natural that many species which had been held for years in good standing—or while known from only a few specimens—should be reduced either to pure synonyms or to the rank of geographical forms or subspecies. It was further natural that in some instances it should be presumed, on general grounds, that certain of the previously recognized species were either purely nominal or else only local forms, even where the evidence was far from conclusive. For a time, under the new order of things, it was not strange that undue lumping should result, as later researches have proved was the case.

"Intermediates" were at first explained on the ground of hybridity, and it was customary for a time to treat the few refractory specimens then known as hybrids. But the hybrids soon became troublesomely numerous; furthermore, it was noticed that over certain areas, and along certain geographical lines, the variations were in general of a similar character. As already said, this gave rise to the recognition of certain laws of geographical variation. A crisis resulted respecting methods of treatment, culminating about 1870. Down to about this date a collection of individuals known as a species was, theoretically at least, a distinct and definable group. Varieties, in a geographical sense, were rarely recognized, and "subspecies" was an almost unknown term. Many species to which we had long pinned our faith were turning out badly; instead of being stable and well marked, they were found to intergrade with others from which they were supposed to be distinct. This, of course, was always in the case of closely allied species; between many other species no such intergradation was apparent. Thus we had, as it were, two kinds of species, some which intergraded and some which did not intergrade. How were such diverse elements to be treated? This was the question of the hour. Should these strongly marked geographical forms be lumped together under a common specific name and thus wholly ignored in nomenclature, or should we continue to recognize under binomial names all strongly marked forms characterizing particular physiographic areas—in other words, forms having approximately defin-

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N.B.—The Recording Secretary will pay current prices for Nos. 2 & 4 Vol. I. Transactions, and Nos. 9 & 10 Vol. II. Annals.

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able habitats—although known to run into something else; or was there a still better way of expressing such important biologic facts? Here were evidently recognizable stages in the process of evolution by environment. How were they to be recognized so as to be made use of in philosophical biology; in what way could they be chronicled in descriptive biology? That many of these intergrading forms possessed noteworthy differences is evident from the fact that they formerly held the rank of unquestioned species.

For a time a wavering course was followed, some writers lumping as one species all forms that seemed to intergrade, while others continued to recognize all of the more prominent phases as species. Soon after it became the fashion to distinguish them as varieties, under what may be termed a qualified quadrinomial system of nomenclature. Thus our Eastern red squirrel, or chickaree, was called *Sciurus hudsonius;* its Rocky Mountain representative, or Fremont's chickaree, became *Sciurus hudsonius*, var. *fremonti;* another Rocky Mountain form, known as Richardson's chickaree, became *Sciurus hudsonius*, var. *richardsoni;* a Northwest coast form, known as Douglass' chickaree, became *Sciurus hudsonius*, var. *douglassi;* and so on in all similar cases. This proved a cumbersome method, and soon the term "var." was dropped, resulting in a trinomial name, pure and simple, for the designation of *subspecies.* This in reality is the binomial system of Linné in spirit, modified slightly in the letter to fit what was an ideal system of nomenclature at the time of its inception, to the requirements of modern biology. Hence American mammalogists adopted, in common with ornithologists, trinomial designations for nascent species, reserving the binomial distinctively for species in full standing. This system became generally current about 1883.

The several geographic, intergrading forms of a wide-ranging species often differ more from each other in their extreme phases than do, in other cases, perfectly distinct species. Hence, through the use of trinomials, two important things are accomplished: first, a means of distinguishing two kinds of relationship among congeneric forms, the use of a binomial name indicating entire distinctness, without regard to kind or degree of difference, while the use of a trinomial implies known intergradation, notwithstanding the very wide difference which frequently exists between the extreme phases of a group of intergrading or conspecific forms; secondly, provision for a convenient and tangible way of giving expression, by means of a definite formula, to some of the most suggestive facts in the evolution of life. It is not claimed that this is a perfect system of nomen-

clature, but it is the best and most convenient at present available. It has its objections, which, theoretically, seem insuperable, but which, in practice, prove insignificant.

At first, under this method, lumping flourished to a remarkable degree. Forms that were known to intergrade were not only reduced to subspecies, but not infrequently such reductions were made on theoretical grounds. Certain forms, judging from what had been established as occurring in allied groups, and in accordance with what might be presumed to occur as the result of certain laws of geographical variation, were presumptively merged with others, sometimes correctly, but often improperly.

It was during this phase of affairs that the "Monographs of North American Rodentia" appeared, as also Coues' "Fur-Bearing Animals" and my "North American Pinnipeds." It was also from this point of view that True prepared his "Check-list of North American Mammals," published in 1884. Incidentally both Coues and myself did some revisionary work in other groups, on nearly the same lines.

To throw into strong contrast the work of the three leading periods in the recent history of North American mammalogy, we will compare briefly two or three groups as left by Baird in 1857, by Coues and Allen in 1877, and as they appear from the standpoint of to-day. For this purpose we will select the Muridæ, or the field rats and mice; the Saccomyidæ, or the pouched rats and mice; the Leporidæ, or the hares; and the Sciuridæ, or the squirrels, spermophiles, and marmots.

In 1857 Baird recognized forty-eight species of field rats and mice; of these Coues reduced eighteen to synonyms and three others to subspecies. There has been no recent revision of the group as a whole, nor in fact of any of the genera. An entirely new genus, however, of meadowmice (*Phenacomys*), with four species, has been recently described by Dr. Merriam,[1] of which not a single specimen had been recognized by naturalists three years ago, although the genus is now known to range across North America from British Columbia to Labrador, and southward along the Rocky Mountains into the United States. Six different writers have described new species of the genus *Hesperomys*, or white-footed mice, three of them being remarkably unlike anything previously known. Several of Baird's species have also been revived as perfectly tenable subspecies. Other genera of this large family present a similar history. In short, not less than thirty species and subspecies have been

[1] "North American Fauna," No. 2, Oct., 1889, pp. 27–35, pll. ii.–vii.

added during the last six years, nearly doubling the number recognized in 1877.

Of the squirrels, Baird admitted thirty-nine species — an enormous reduction, by the way, from the number recognized by Audubon and Bachman. In 1877 I confirmed Baird's previous reductions, and still further reduced the number to thirty-three species and subspecies, adding, however, eight to those recognized by Baird. Since 1877 a large number of species and subspecies has been added, mainly among the ground squirrels and spermophiles. These additions are based on almost wholly new materials, and include species as distinct from their nearest allies as any previously known. That is, they are not the result of a new way of looking at things, but are actual discoveries of forms not at all closely related to anything known before.

Of the Saccomyidæ, Baird in 1857 recognized nine species; Coues, in 1877, admitted the same number. This group during the last four years has been thoroughly revolutionized, mainly by Dr. Merriam.[1] The names of several of the old species have been shown to have been strangely misapplied; one new genus and a new subgenus, and some twenty or more new species, have been added, besides numerous subspecies. Among the new forms are some strikingly different from any known to either Baird or Coues, while others differ in only comparatively slight particulars. These animals are peculiar to the arid plains and deserts of the West; are nocturnal and somewhat subterranean in their habits, and seem, moreover, especially susceptible to the influence of conditions of environment. Owing to their peculiar habits, and to the fact that the area they inhabit has been, till lately, little explored, very few specimens were extant in collections up to a very recent date.

Of the Leporidæ, or hares, Baird in 1857 was able to recognize but thirteen species as North American. All but one of these were admitted by me in 1877 and two others were added. Within the last year five others have been recognized, three of which are very distinct from any previously known, while two are old ones revived as subspecies.

To what, then, is all this change due? To several very obvious causes. First, to a vast increase of material; second, to its greatly improved quality; third, to more thorough and intelligent work in the field, conducted on a tenfold greater scale than ever before. Thousands of specimens are taken now where formerly only a few scores were obtained. Collecting and all

[1] "North American Fauna," No. 1, Oct., 1889; ibid., No. 3, Sept., 1890, pp. 71–75; and ibid., No. 4, Oct., 1890, pp. 41–49.

that relates to field work in mammals has been brought to an almost ideal state of proficiency. And all this is due, primarily, to the efforts and example of one man—Dr. C. Hart Merriam, formerly of Locust Grove, Lewis County, New York, now Chief of the Division of Ornithology and Mammalogy of the United States Department of Agriculture. He, realizing the importance of well-prepared skins, in large series from as many localities as possible, and of accurate data as to time and place of capture, and of measurements taken from the specimen before skinning, began, many years since, to form a collection for his own cabinet, which eventually became one of the most extensive and valuable in the country. An expert himself in all that relates to the capture and preservation of specimens, he trained collectors and sent them to remote parts of the country, and soon gathered a rich harvest, replete with novelties, some of them of startling character, so widely did they differ from anything previously known. Later, under the auspices of the Department of Agriculture, he has pushed the work with still greater activity, resulting in the recent establishment of what practically amounts to the inception of a Biological Survey, on a grand scale, of the United States, which, in the interest of science and in the economic interests of the country, it is to be hoped will be long liberally sustained.

The number of skilled collectors is rapidly increasing, with the result that our leading museums are now receiving much more and far better material than was ever before available for study. To contrast once more the old with the new, it may be stated that more specimens of the smaller mammals of North America were collected during the year 1890 than all that Professor Baird had at his command in 1857 for the preparation of his great work on North American mammals—specimens, too, incomparably better as regards their quality and utility for scientific investigation.

While, ten or twelve years ago, it was commonly supposed that comparatively little remained to be learned respecting the mammals of North America, beyond a few details regarding their distribution and habits, we are now little less than awed by the evident extent of our ignorance of the subject, as shown by the astonishing discoveries of the last four or five years, and recognize the obvious necessity of a careful revision of the whole field.

From this point the paper was continued extemporaneously, and the speaker, by means of specimens for illustration, showed the difference in the character of the material formerly avail-

able for study and that now employed. He also illustrated the wide range of seasonal variation in color occurring among the ground and tree squirrels of the genera *Tamias* and *Sciurus;* and exhibited and described a number of the more remarkable forms of mammalian life recently discovered in various parts of North America.

March 2d, 1891.

REGULAR BUSINESS MEETING.

VICE-PRESIDENT PROF. ALLEN in the chair.

About thirty persons present.

The minutes of the meetings of February 2d and 23d were read and approved.

The following recommendations of the COUNCIL (February 6th and 26th) were approved, and the Fellows and Members duly elected :

I. The election of

L. H. JACOBY,
EMORY MCCLINTOCK, and
JOHN TATLOCK, JR., as Fellows.

II. The election of

GEORGE H. ENGLISH as Resident Member.

III. The formation of a Section of Archæology.

In conformity with the notice for the evening, PROF. ALLEN announced that the Section of Astronomy would be temporarily organized. PROF. ALLEN retired, and PROF. REES was chosen provisional chairman of the Section, with MR. HAROLD JACOBY as secretary. On motion, the chairman was requested to appoint a committee of three to perfect the organization and lay out the work of the Section.

The following papers were read :

ON THE CALCULATION OF STAR-PLACES FOR ZENITH TELESCOPE OBSERVATIONS.

BY HAROLD JACOBY.

(Abstract.)

In determining the latitude from zenith telescope observations it is not necessary to compute the "reduction from mean to apparent place" of every star observed. For the stars are observed in pairs; and to obtain the latitude we need to know the *mean* of the apparent declinations of the two stars of any pair. It follows, therefore, that we only require the mean of the corresponding reductions for the two stars.[1] This mean can be arrived at by a single computation, which may be effected nearly as quickly as the reduction of either star could be separately computed.

Let

α_1, δ_1, be the right ascension and declination of the Southern Star,

α_2, δ_2, the same quantities for the Northern Star,

and put:

$$t = \tfrac{1}{2}(\alpha_2 - \alpha_1) \qquad \zeta = \tfrac{1}{2}(\delta_2 - \delta_1)$$
$$\alpha_0 = \tfrac{1}{2}(\alpha_2 + \alpha_1) \qquad \delta_0 = \tfrac{1}{2}(\delta_2 + \delta_1)$$

The correction which must be added to the latitude, computed simply with the mean declinations for the beginning of the year, is then given by the following equations:[2]

$$\Delta\varphi = ix + \tau\mu_0 + g\cos(G + \alpha_0)\cos t + hm_0\cos(H + \alpha_0 + kt)\cos\zeta$$
$$k = \cot\varphi\tan\zeta$$
$$x = \cos\varphi\cos\zeta$$
$$m_0 = \sin\delta_0\cos t$$

k, x, and m_0 are auxiliary quantities, having constant values for any particular pair of stars. The other letters have their usual significance (see *American Ephemeris*), and μ_0 is the mean of the proper motions of the two stars in declination.

In applying this method it will be expedient to tabulate x, k, and $\log m_0$ (which are always positive) for the latitude of the observing station. The formation of such a table requires but a very few minutes, as will be seen from the following example:

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[1] See also a paper by Prof. T. H. Safford, Pro. Am. Ac. Arts and Sciences, 1875, Vol. XI., p. 167.

[2] For a demonstration of these formulæ, see Astronomical Journal, No. 238.

Let the given quantities be:

$\varphi = 40° 45'$, or the latitude of Columbia College.

Date = 1886, November 2d, Washington, mean midnight.

$\alpha_2 = 2^h 28^m.0 \quad \delta_2 = 60° 45' \quad \mu_0 = 0$

$\alpha_1 = 2^h 10^m.0 \quad \delta_1 = 20° 35'$

The tables referred to above are, for the latitude 40° 45′ :

For x and k		
ζ	x	k
0°	+ 0.758	+ 0.00
5	0.755	0.10
10	0.746	0.20
15	0.732	0.31
20	0.712	0.42
25	+ 0.687	0.54

For log m_0			
t	$\delta_0 = 40°40'$	40° 45′	40° 50′
0^m	9.8140	9.8148	9.8155
5	9.8138	9.8146	9.8153
10	9.8136	9.8144	9.8151

From the *American Ephemeris :*

$G = 2^h 7 .9 \quad H = 3^h 7 .3 \quad i = 6''.17$

$\log g = 1.1944 \quad \log h = 1.2899$

We have, then:

$\alpha_0 = 2^h 19^m.0, \quad t = + 9 .0, \quad \delta_0 = 40° 40', \quad \zeta = 20° 5'$

and therefore, from the above little tables, for this pair of stars:

$x = 0.712 \quad k = 0.42 \quad \log m_0 = 9.8136$

so that

$kt = + 3 .8 \qquad \alpha_0 + kt = 2^h 22^m.8$

$g \cos (G + \alpha_0) \cos t = + 6''.18$

$hm_0 \cos (H + \alpha_0 + kt) \cos \zeta = + 1.55$

$ix = + 4.39$

$\Delta\varphi = + 12.12$

A calculation of the two stars separately gives for the respective reductions

10″.46 and 13″.79

whose mean is 12″.12, agreeing exactly with the result found above.

AN INDEX TO "COPERNICUS," AN INTERNATIONAL JOURNAL OF ASTRONOMY.

BY JOHN TATLOCK, JR., M.A.

Introduction.

In 1881 Dr. Ralph Copeland and Dr. J. L. E. Dreyer commenced the publication of an astronomical journal called

Urania. After six numbers had been issued, becoming aware of the existence of an *astrological* journal of the same name, the editors changed the appellation of their publication to *Copernicus*, under which name three complete volumes were published, the last number of the journal being dated in June, 1884. The discontinuance of the publication of *Copernicus* was a source of great regret to astronomers, for it occupied a unique position among the journals of its class—a position which, to a very large extent, has never been occupied by any other publication.

It is with a view of furnishing a means of reference to the many valuable papers of permanent interest contained in *Copernicus* that the following index has been compiled. It is hoped that it will be found to be a worthy contribution to astronomical bibliography.

The index is arranged in two parts: the first contains a list of contributors to the journal, with the titles of their papers or articles in chronological order; the second part contains the contents of the journal, arranged under the various general subjects to which the papers respectively belong.

The Roman numerals refer to the volumes, the Arabic to the pages.

The critic will note various departures from the established rules which are supposed to govern the formation of a bibliographical index. In extenuation it may be said that no attempt has been made to follow closely the usual forms and methods, but that the object has been to present the material in the most available form.

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12. Venus.
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18. Stars, Double.
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Comet of 1812 (Brooks', 1883), Observations of. III., 131.
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——Observations of. I., 4.
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Comet 1880 *f* (Pechüle), Observation of the Spectrum of. I., 40.
Comet Encke, Observations of (in 1881). I., 182 and 186.
Comet *a* 1881 (Swift), Elements and Ephemeris of. I., 120, 121.
——Observations of. I., 122.
Comet *b* 1881, Elements, Ephemeris, and Observations of. I., 141, 161, 163, 177, 211 ; II., 42, 60.
——The Polarization of Light from. By Arthur W. Wright. I., 157.
——Observations of the Spectrum of. I., 162.
Comètes *b* et *c* 1881, Recherches sur les. Par Th. Bredichin. II., 1.
——Note supplémentaire sur les. Par Th. Bredichin. II., 56.

Comet *c* 1881 (Schaeberle), Elements, Ephemeris, and Observations of. I., 163, 181, 182, 186 ; II., 60.
——Polariscopic Observations of. By Arthur W. Wright. I., 214.
Comet *e* 1881 (Barnard), Elements, Ephemeris, and Observations of. I., 206, 221, 237.
Comet *f* 1881 (Denning), Elements, Ephemeris, and Observations of. I., 212, 222 ; II., 42.
——On the Orbit of. By William E. Plummer. III., 1.
Comet *g* 1881 (Swift), Elements, Ephemeris, and Observations of. I., 238 ; II., 19, 20, 42.
Comets III. and IV. 1881, Comet I. 1882, and the Great Comet of 1882, Spectroscopic Observations of. By Ralph Copeland and J. G. Lohse. II., 225.
Comet Wells, 1882, Elements and Observations of. II., 94, 95, 96.
——The Spectrum of. II., 157.
Comète 1882 I. (Wells), Sur la. Par Th. Bredichin. III., 41.
Comète de 1882 II., Recherches sur la. Par Th. Bredichin. III., 81.
Comet 1883 I., Spectroscopic Observations of. III., 130.

II. HISTORY OF ASTRONOMY.

Observatory at Peking, The Instruments in the Old. By J. L. E. Dreyer. I., 134.
Recherches sur l'Astronomie des Anciens. Par H. C. F. C. Schjellerup. I. Sur le Chronomètre Céleste d'Hipparque. I., 25.
——Ibid. II. On the Total Solar Eclipses observed in China in the Years B.C. 708, B.C. 600, and B.C. 548. I., 41.
——Ibid. III. Sur les Conjonctions d'Étoiles avec la Lune rapportées par Ptolémée. I., 223.
Record of the Progress of Astronomy during the Year 1880. By the Editors. I., 56. A detailed account of the principal investigations made and results published, during the year, in the various departments of Astronomy.

III. METEORIC ASTRONOMY.

Meteor Streams, by W. F. Denning. I., 194. A list and description of "a few of the most active meteor showers observed at Bristol since 1876."
Ueber das Zodiakallicht. Von Prof. W. Klinkerfues. II., 91.

IV. PRACTICAL ASTRONOMY.

On the Determination of the Error and Rate of a Clock by the Method of Least Squares. By Ormond Stone. I., 116. The author applies the formulæ which he develops to a discussion of the rates of the Leiden Clock, Hohwü No. 17, as given by Kaiser in Ast. Nach., vol. 63, pp. 215–220.
Positionsringmikrometer, Das. Von Dr. H. Kobold. I., 187.

V. SIDEREAL ASTRONOMY.

Comparison Stars. A Suggestion to Astronomers (J. L. E. Dreyer). I., 49. Dr. Dreyer suggests that a good field for a transit circle is

the observation on a systematic plan of the comparison stars used in the observations of planets and comets, and for which satisfactory catalogue places cannot be found.

Sidereal System, On the Theory of the, proposed by Mr. Maxwell Hall. By W. E. Plummer. II., 45. A review and examination of Mr. Hall's paper published in the 43d vol. of the Memoirs R. A. S., in which the author attempts "to connect Proper Motion with Annual Parallax, and with the radial velocity of the fixed stars." From the tests which he applies to Mr. Hall's theory, Mr. Plummer regards the latter's results as inconclusive and untrustworthy.

Telescopic Stars, Christian Mayer's Observations of, arranged according to Constellations (H. C. F. C. Schjellerup). III., 57.

VI. SPHERICAL ASTRONOMY.

Polhöhe, Ueber eine Methode die, möglichst frei von systematischen Fehlern zu bestimmen. Von Prof. J. C. Kapteyn. III., 147.

Precession, Constant of, A New Determination of the. By J. L. E. Dreyer, Ph.D. II., 135. Contains a description of the previous labors of Bessel, Struve, and Nyrén on this subject. Dr. Dreyer takes as the basis of his work Lalande's "Histoire Céleste" and Schjellerup's catalogue of 10,000 stars, and deduces a result which, for 1800.0, is only 0″.0046 less than the Struve-Peters constant.

Right Ascensions, Lalande's, Note on the Accuracy of. By J. L. E. Dreyer. III., 103.

VII. THEORETICAL ASTRONOMY.

A Comparison of Le Verrier's Tables of Uranus and Neptune with those by Newcomb of the same Planets. By David P. Todd, M.A. III., 233.

Kepler'sche Problem, Ueber das. Von Prof. J. C. Kapteyn. III., 25.

Kepler, Remarques concernant le Problème de. Par M. R. Radau. III., 132.

Lambert'schen Gleichung für parabolische Bewegung, Ueber die Auflösung der. Von Prof. W. Klinkerfues. I., 5.

Problems der Drei Körper, Eine neue Behandlung des. Von Dr. H. Kobold. II., 69.

Problem der Drei Körper, Bemerkung zu Dr. H. Kobold's Aufsatz über das. Von Prof. Aug. Weiler. II., 130.

Special Perturbations, Note on the Computation of. By Ormond Stone. II., 120.

Theorie der Bewegung der Himmels-Körper, Prof. Gyldén's Neue Untersuchungen über die. Von Dr. O. Backlund. II., 203.

Wahren Anomalie, Ueber den zweiten Differentialquotienten der. Von W. Klinkerfues. II., 163.

Wahren Anomalie genommen, Ueber den zweiten Differentialquotienten von x nach der. Von August Weiler. III., 16.

VIII. ASTRONOMICAL BIBLIOGRAPHY.

"Cycle," A few Addenda to Admiral Smyth's (Editors). II., 93.

Manuscript der Pulkowaer Sternwarte, Ueber ein altes. Von A. Wagner. II., 123. An Arabian manuscript containing data concerning the annual increase in the mean longitude of the sun, from which M.

Wagner deduces the length of the tropical year=365 days, 5 hours, 48 minutes, 46 seconds. Dr. Dreyer contributes some notes on M. Wagner's paper, as an appendix thereto.

Recent Literature. Under this head the Editors have furnished reviews of monographs and papers on various subjects. The papers reviewed are indexed chronologically as follows:

I., 139.

Variable Stars of Short Period. By Edward C. Pickering (Proc. Amer. Acad., Vol. XVI.).

Bibliographie générale de l'Astronomie. Par J. C. Houzeau et A. Lancaster.

Observations on Jupiter, by L. Trouvelot (Proc. Amer. Acad., Vol. XVI.).

Spectrum of Lalande 13412 (E. C. Pickering, Science, No. 41).

A Lost Comet (E. E. Barnard, Science, No. 47).

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Reports on the Total Solar Eclipses of July 29, 1878, and January 11, 1880. Issued by the U. S. Naval Observatory.

Large Telescopes. By Edward C. Pickering (Proc. Amer. Acad., Vol. XVI.).

Observations of Double Stars made at the U. S. Naval Observatory by Asaph Hall (Wash. Obs., 1877, App. VI.).

Contributions from the Washburn Observatory of the University of Wisconsin, Number 1.

Note on Photographs of the Spectrum of the Comet of June, 1881. By Prof. H. Draper (Amer. Journal, August, 1881).

I., 196.

Visite à divers Observatoires d'Europe : Notes de voyage par M. J. Perrotin, Directeur de l'Observatoire de Nice.

Recherches sur la Verticale. Par M. Antoine d'Abbadie (Annales de la Société Scientifique de Bruxelles, 1881).

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Ueber den Doppelstern Σ 60 = η Cassiopejæ. Von Ludwig Struve (Mélanges mathém. et astron., T. V.).

Note sur l'analyse de la lumière de la Comète de (*b*) 1881. Par Ch. Fievez (Bulletin de l'Acad. R. de Belgique, 3me série, T. I.).

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Celestial Objects for Common Telescopes. By the Rev. T. W. Webb. Fourth edition, revised and greatly enlarged.

Annual Report of the Director of the Dearborn Observatory, Chicago.

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Catalogue of 12,441 Stars for the epoch 1880, from observations made at the Royal Observatory, Cape of Good Hope, during the years 1871 to 1879. By Edward James Stone, M.A., F.R.S., etc.

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Photometric Measurements of the Variable Stars β Persei and D. M. 81.°25. By Edward C. Pickering, Arthur Searle, and O. C. Wendell. (Proc. Amer. Acad., Vol. XVI.).

I., 239.

G. Schiaparelli: Osservazioni astronomiche e fisiche sull' asse di rotazione e sulla topografia del pianeta Marte (Atti della R. Acad. dei Lincei, Serie III.; Transunti, Vol. 5).

Observations sur l'aspect physique de Jupiter pendant l'opposition de 1878. Par L. Niesten (Annales astron. de l'Obs. R. de Bruxelles, T. III.).

Astronomische Mittheilungen, von Dr. Rudolf Wolf, No. 53.

Reports of American Observatories (1879).

A Determination of the Solar Parallax from Observations of Mars made at the Island of Ascension in 1877. By David Gill, LL.D. (From the Mem. R. Astron. Soc., Vol. 46.)

II., 20.

On the Relative Accuracy of Different Methods of Determining the Solar Parallax. By Wm. Harkness (Amer. Jour., November, 1881).

Observations of the Transit of Mercury, 1881, November 7, at Mount Hamilton, Cal. (Communicated by the Lick trustees.) By Edw. S. Holden and S. W. Burnham (American Journal of Science, January, 1882).

Zur Theorie des Encke'schen Cometen. Von O. Backlund (Mém. de l'Acad. Imp. de St. Pétersbourg, 7me série, T. 28, No. 6).

II., 44.

Account of Observations of the Transit of Venus, 1874, December 8, made under the Authority of the British Government, and of the Reduction of the Observations. Edited by Sir George Biddell Airy, K.C.B. Printed for H. M. Stationery Office, 1881.

II., 65.

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Thirty-sixth Annual Report of the Director of Harvard College Observatory. By E. C. Pickering.

II., 97.

Sur le compagnon de l'étoile γ d'Andromède et sur un nouveau mode de réglage d'un équatorial (Compt. Rend., T. XCIV.).

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III., 35.

Resultados del Observatorio Nacional Argentino en Córdoba. B. A. Gould. Vol. ii., Observaciones del Año 1872 (Buenos Aires, 1882).

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Bestämmandet af en Planets massa medelst iakttagelser af satelliternas indbördes lägen. Af O. Backlund (Proc. R. Swedish Acad., 1882).

III., 51.

Bestimmung des Masse des Planeten Jupiter aus Heliometer Beobachtungen der Abstände seiner Satelliten. Von Dr. W. Schur (Nova Acta der Leop. Carol. Acad., Band XLV., Halle, 1882).

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III., 79.

Monograph of the central Parts of the Nebula of Orion. By Edward S. Holden (Wash. Obs. for 1878, App. I.).

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III., 145.

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On the Influence of Magnetism on the Rate of a Chronometer. By O. Boeddicker (Trans. R. Dublin Soc. Vol. III.).

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IX. ASTRONOMICAL BIOGRAPHY.

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Klinkerfues, The late Professor. Ralph Copeland. III., 239.

Robinson, Thomas Romney. Obituary Notice (Editors). II., 64.

Powalky, Carl Rudolf. Obituary Notice (Editors). I., 165.

X. THE SUN.

Chromosphere, The, in 1880. By the Rev. S. J. Perry. I., 97.
——in 1881. By S. J. P. II., 62.
——in 1882. By S. J. P. III., 102.
——in 1883. By S. J. P. III., 232.

Parallax, On the Solar, as derived from the American Photographs of the Transit of Venus, 1874, December 8-9. By D. P. Todd, M.A. I., 167. From a preliminary discussion of the equations formed from the measures of the photographic plates, the author finds a value of $\pi = 8.''883$.

Tables écliptiques, Supplement aux, de P. A. Hansen. Par H. C. F. C. Schjellerup. I., 155. The tables to which these are an addendum are published in Berichte der K. Säch. Gesell. der Wissenschaften, IX. (1857), pp. 75-112.

Sonnenfinsterniss, Beobachtung der partiellen, zu O'Gyalla, 1882, Mai 16. (Dr. H. Kobold). III., 76.

Sonnenflecken, Beobachtungen von, am Astrophysicalischen Observatorium zu O'Gyalla (Dr. H. Kobold). II., 89, 131, and 196.

XI. THE MOON.

Hülfstafeln zur Erleichterung der Berechnung von Sternbedeckungen durch den Mond. Von Dr. C. Börgen. I., 8. Errata in certain of the formulæ contained in this paper are found in I., 49.

Lunar Radiant Heat, Determinations of the, during the Progress of an Eclipse. By the Earl of Rosse. I., 22.

XII. VENUS.

Venus, Satellite of, On some hitherto Unknown Observations of a Supposed. By H. C. F. C. Schjellerup. II., 164. The observations referred to are seven made by Roedkiaer in 1761, and one made by Horrebow in 1768, at the Copenhagen Observatory.

Venus, Transit of, Observation of the, 1882, December 6, at the Armagh Observatory. By J. L. E. Dreyer. III., 18.

Venus, Transit of, Observation of the, 1882, December 6, at Markree Observatory. By W. Doberck. III., 19.
——Ibid., The Government Expedition to Madagascar to observe the, on December 6, 1882. By the Rev. S. J. Perry, F.R.S. III., 67.
——Ibid., Observation of the, December 6, 1882, at the Observatory of Queen's College, Cork. By Prof. J. England. III., 75.
——Ibid., Observation of the, 1882, December 6, at Dun Echt Observatory. By J. G. Lohse. III., 129.

XIII. MARS.

Mars in 1881–82, Note on the Aspect of. By C. E. Burton. II., 91.

XIV. JUPITER.

Jupiters, Beitrag zur Kenntniss der Rotationselemente. Von Dr. H. Kobold. I., 123.

XV. NEPTUNE.

Neptune, Historical Note concerning the Discovery of. J. L. E. Dreyer. II., 63. Dr. Dreyer shows that d'Arrest as well as Galle took part in the observations that finally resulted in the discovery of Neptune.
Neptune, Ueber die erste Auffindung des Planeten. J. G. Galle. II., 96.

XVI. MINOR PLANETS.

Kleiner Planeten, Beobachtungen, am Reichenbach'schen Meridiankreise zu Göttingen (Dr. H. Kobold). I., 94. Observations during 1880 of Nos. 3, 4, 5, 6, 7, 11, 14, 15, 20, 40, 43, 51, 78, 119.
Prize Question of the Royal Danish Society of Science. III., 51. The Society here offers a gold medal "for a statistical investigation of the orbits of the Minor Planets, considered as parts of a ring around the sun."

XVII. NEBULÆ.

Merope, Note on the Nebula near. By J. L. E. Dreyer. I., 156.
Nebulæ, New. By A. Ainslie Common. I., 50.
Orion, Photograph of the Nebula in (Editors). I., 160. Notice of the photograph of this object taken by Prof. Henry Draper on March 11th, 1881.
Orion, The Spectrum of the Nebula in, photographed (Editors). II., 68. Notice of Dr. Huggins' photograph of the spectrum taken on March 7th, 1881.
Planetary Nebula, A New. By Ralph Copeland, Ph.D. I., 2.
Planetary Nebula, New. Edward C. Pickering. I., 242.
Positions of Nebulæ, Series I. By C. H. F. Peters. I., 51.
——Ibid., Series II. By C. H. F. Peters. II., 54.

XVIII. DOUBLE STARS.

Double Stars, Recent Measures of. By C. E. Burton. I., 54.
Double Stars, On some Interpolation Formulæ for. By Prof. T. N. Thiele. II., 25. A very complete discussion of the most advantageous formulæ for the computation of double star orbits, under varying conditions as regards the data to be used. Contains also a set of auxiliary tables.

On γ Virginis considered as a Revolving Double Star. By W. Doberck. I., 143. A discussion of observations of this pair extending from 1718 to 1881.

XIX. RED STARS.

Red Stars, List of, observed at the Washburn Observatory, University of Wisconsin, Madison. By Edward S. Holden. I., 176.
Red Stars, Markree Observations of. By W. Doberck. I., 208.

XX. VARIABLE STARS.

Nova Cygni, Spectroscopic and other Observations of Schmidt's, made at Dun Echt Observatory (Ralph Copeland and J. G. Lohse). II., 101.
Variable Star, A New (Editors). I., 238, and II., 157. The star is D. M. + 1°, 3408.

XXI. STELLAR PARALLAX.

Researches on the Annual Parallax of the Star Groombridge, 1618. By Prof. Robert S. Ball, LL.D., F.R.S., Royal Astronomer of Ireland. I., 16.
Determination of the Annual Parallax of 6 Cygni B = Σ 2486. By Robert S. Ball, LL.D., F.R.S., Astronomer Royal for Ireland. II., 159.
On the Parallax of the Star Bradley, 3077. By O. Backlund. II., 201. A discussion of an incomplete series of differences of Right Ascension observed by Wagner at Pulcova with the transit instrument.

XXII. STELLAR SPECTROSCOPY.

Remarkable Star Spectrum. Edward C. Pickering. I., 242.

XXIII. MISCELLANEOUS SUBJECTS.

An Account of some recent Astronomical Experiments at high elevations in the Andes. By Ralph Copeland, Ph.D. III., 193.
Corrections. I., 242; II., 244.
Extracts from Two Letters from South America. Ralph Copeland. III., 66.
Jottings on the Science of the Chinese. By Alexander Wylie. II., 169.
Meeting of the "Astronomische Gesellschaft" at Strassburg, September 22–24, 1881, The. I., 200.
Notes on a recent Visit to some North American Observatories. By Ralph Copeland. III., 133.
On the Telegraphic Transmission of Astronomical Data. I., 179.
U. S. Naval Observatory during the Year ending October 31, 1880, The. I., 48.

REMARKS ON THE REDUCTION OF RUTHERFORD STAR PLATES.

BY J. K. REES.

(No Abstract.)

PROF. REES exhibited some of the negatives made by MR. RUTHERFORD, and explained the operation of the apparatus for making the measurements.

After the reading of these papers the Section adjourned and PROF. ALLEN again took the chair.

MR. C. A. POST was proposed as a Resident Member.

The following committees have been formed by the COUNCIL:

On Nominations—The entire COUNCIL.

On the Library—MESSRS. ALLEN, BRITTON, COX, JULIEN, and NEWBERRY.

On Publications—MESSRS. ALLEN, BOLTON, CASEY, MARTIN, NEWBERRY, and REES.

On Public Lecture Course—MESSRS. BOLTON, JULIEN, and TROWBRIDGE.

March 9th, 1891.

STATED MEETING.

VICE-PRESIDENT DR. HUBBARD in the chair.

About fifty persons present.

The following paper was read:

ADAPTATION OF THE ARC LIGHT TO PROJECTIONS.

BY L. H. LAUDY, PH.D.

(Abstract.)

The introduction of electricity into the business of life is one of the noteworthy features in the history of the civilization of the nineteenth century.

It is true that before 1850 science had discovered nearly all the facts upon which the present industrial applications of electricity depend, and the laws and principles had all been announced at a much earlier date. Most of us are familiar with the galvanic battery, the magneto-electric machine, the telegraph, and the electroplating bath, but at that time so limited was the application and so small the current necessary that the world would hardly have felt the loss if by some strange accident the agent had disappeared.

To-day the great industries and business centres depend largely upon electricity for the transmission of sound, telegraphic communication, light and power; and the enormous demands made upon it, and the important position that it occupies in the industrial arts, are convincing proofs that it has come to stay.

Every day brings to light some new application, and its use develops with increasing rapidity. A few years ago we depended upon the galvanic battery for our electricity. For telegraphy and electro-chemistry this answered, at that time, the purpose. It was costly and troublesome, and many attempts had been made to substitute mechanical generators for the production of electricity by the motion of coils of wire in a magnetic field; it was not until some time after the discovery of Faraday in 1832 that mechanical motion was applied to the production of electric currents.

The electric industry has been born and carried to its present state of development within the past ten years. At no time in the history of the world have such rapid strides been made in any of the applied sciences. This is due largely to the marvellous skill and competition of inventors, manufacturers, and users of so important a commodity; and now, for the first time in the history of the world, electricity has become the subject of commercial contracts, is bought and sold as a commodity of every-day use, recorded and charged for in terms of energy itself, used at the pleasure and convenience of the consumer for lighting, heating, mechanical, and chemical purposes.

Electricians should be congratulated for giving us a commodity that is not capable of adulteration—for a given strength and electromotive force is perfectly defined, no matter how it may be generated or what machine produces it, and with these two measures we can calculate the energy consumed. For by multiplying the volts by the ampères we get the value expressed in watts, 746 of which are equivalent to one horse power. . . . I need hardly tell you that at the present time the most important applications of electricity are for light and power.

As regards the illumination of large spaces by the arc light, and the further subdivision for domestic uses of the incandescent light, the problem may be considered solved. It has been used for lantern projection to a limited extent, but I hope to see a general adoption of the arc light for this purpose; and having devoted some time to the subject, following it up from the days in which the current was produced from batteries, until to-day when we have on tap a current of electricity as we have gas and water supply, it seems most fitting that my experience should be given to the members of this Society, and my object in inviting you here this evening is to give you some experimental facts, and to ask your verdict as to its application for lantern projections.

For lantern projections the usual method is to make use of incandescent lime; this was a great advance over the *oil lamp*.

To-night I wish to show you the most intense light known to science, and its adaptation for purposes of projection, which is only awaiting a general adoption for use in the optical lantern. There is no obstacle to prevent its use, and it recommends itself upon its merits to all workers in this direction. . . .

(A brief history of the electric light follows.) The electric light is the outgrowth of the experiments of Sir Humphry Davy, made at the Royal Institution, London, in 1801, when he made use of 2,000 cells with which he decomposed sodic and potassic hydrates and separated their metallic bases.

These experiments were repeated and extended, and by using charcoal points as terminals an intense and dazzling light was produced, to which the name voltaic arc was given.

The arc light, then produced from a battery, brilliant as it is, was confined to the lecture-room or an occasional outdoor display. The fatal difficulty was the labor and cost of the electrical energy, and it was not until the discovery of induced currents by Faraday that this obstacle was removed. The light produced by the voltaic arc received no practical application until 1844, at which time it was regarded as an interesting lecture experiment, requiring the use of large and powerful batteries, together with suffocating fumes, and labor for a possible use of one or two hours. In 1844 Leon Foucault made use of the Bunsen battery, and replaced the charcoal points used by Davy with pieces of compact gas carbon. He also constructed a lamp worked by hand, and the first use made of it was in taking daguerreotypes and lighting La Place de la Concorde at Paris.

It required the combined labors of Nollet, Van Maldern, Holmes, Wilde, Ladd, and Siemens to produce by mechanical means, direct from motion, a supply of electrical energy that would equal that produced from the battery. Even as late as 1870 this did not seem possible, for the best dynamos at that time yielded only a small amount of electrical energy.

In 1871 Gramme presented to the Academy of Science the description of a form of magneto-electric machine possessing new features, which were so remarkable as to astonish the world. Gramme conceived the idea of using a ring, and rotating this between the poles of a magnet in such a way as to prevent reversals in the armature. Many ridiculed this idea. Nevertheless it produced in practice a machine that yielded large currents at much less cost, and laid the foundation of our present system of electric lighting.

From whatever source the electricity is supplied, it is necessary that it meet with some resistance to produce light, and this

condition is best fulfilled, for the production of the arc light, when two pieces of carbon are made to touch and then slightly separate ; the current in passing between the space so increases the resistance as to produce light of great intensity, and is called the arc light.

That a constant resistance may be obtained favorable to the production of light, some mechanical device that will separate and regulate the distance of the carbons is essential. Such an apparatus is called a regulator, or arc lamp.

There are few inventions on which so much ingenuity has been expended as on arc lamps. The number is already very great and is on the increase, and every bulletin of the Patent Office is sure to contain several inventions of this kind.

The first lamp for regulating the position of the carbons was devised by Thomas Wright, of London, in 1845.

A few years later Le Molt, of France, devised a clockwork regulator which kept the light steady for several minutes at a time, but the flickering was too great to make it of any practical value.

These were followed by Archereaus, Jasper, Iurgenseh, Gaiffe, Reynier, Foucault, and many others, each lamp an improvement on the older forms, which brought the standard of regulators to its present state of perfection. Flickering was regarded at one time as a part of an arc light, just as sparking at the brushes of a dynamo was thought to be a necessary accompaniment.

In 1849 Foucault devised a clockwork regulator that differed in many details from the ones before used and gave comparative satisfaction. It was extensively employed for scientific purposes, and, in fact, was the only lamp that was suitable for lantern projection, and is used to-day in many physical laboratories in preference to other lamps.

The next advance was by Serrin, whose regulator kept the carbons exceedingly steady and maintained them in their relative positions. This lamp has been used for lighthouse illumination, and still maintains that position; for, like the Foucault, it is a focussing lamp, the function of which is to maintain the carbons at a central point. To produce this effect the carbons are so arranged that a different motion is imparted to each, that the wearing away may be compensated for by a more rapid movement of the positive pole with only a gradual waste of the negative carbon. By this simultaneous approach of both carbons, the positive moving through double the distance of the negative, the arc preserves its normal length and its position is maintained in space. This is accomplished by an ingenious

mechanical device, actuated either by clockwork or electro-magnets.

The regulation of the length of arc that shall produce the most intense light with the least current is confined to very narrow limits, and the mechanical construction of the lamp that will yield satisfactory results must be most perfect. In many of the lamps this regulation is still wanting, and lamps lacking the above essentials, that are put together without regard to any electrical laws, with the hope that chance may make them work, produce a hissing and hammering noise that is disagreeable when silence is required, and are not to be recommended for any purpose.

Between the better lamps there is not much to choose for ordinary illumination; but for special purposes, as in the case of lantern projection, some points are of vital importance, for the success will depend mainly upon the steadiness, good behavior, and excellence of the automatic feed and position of the carbons, together with a uniform action of the dynamos. . . . At present arc lights are run both by continuous and by alternating currents—*i.e.*, in some cases the current is steadily in the same direction, while in others the current consists of pulses, alternately positive and negative, succeeding each other at the rate of from 200 to 300 per second. The operation of nearly all the arc lamps in use is based upon the principle that a current of electricity will divide itself in direct proportion to the resistance offered by a conductor. In an arc lamp two ways are provided in which the current can go—either through the low or high resistance coil of the lamp. When the current passes through the low-resistance coil it pulls the feed rod up and strikes the arc; any alteration in the resistance will change the direction of the current, and thus give an automatic movement to the feed rod. When the resistance increases, part of the current will pass through the high-resistance coil, which will depress the feed rod and bring the carbons together. The coils are so wound that the resistances due to a certain separation of arc will just balance each other, thus maintaining a steady light. . . . The design of the lamp depends upon the condition with which it is to be supplied with current; that is, whether it is supplied by a constant potential with a variable current, as is furnished by the Edison Company, or low-tension current—that is, having a voltage of 115 to 120 volts—or whether it is fed from a variable potential and constant current of high voltage, as is used in series arc lighting. This current is known as high potential, and the voltage runs in most cases from 1,000 to 3,000 volts. The objection to the latter is that to make any

adjustment of the lamp the current must be turned off, as the lamp cannot be handled with the current on without danger, possibly attended with fatal results. The current used for projection should be of low tension, for with this the lamp can be handled without danger, and all adjustments may be made while the lamp is in operation. . . . The intensity of the arc depends upon the current used and the size of the carbons. The intensity of the arc light has been variously estimated at from 400 to 2,000 candle power. With a variable arc this will take place, but for purposes of projection this objectionable feature has been removed. With a proper position of the carbons these changes in the intensity of the light fall within narrow limits, and the fluctuation due to mechanical movements in the lamp is small, as the interval of feed is about two seconds. The intensity of the light when the carbons are arranged as described for projection is from 1,200 to 1,500 candle power.

The oxyhydrogen light under the best conditions will yield from 600 to 1,000 candle power. The character and color of the lime light are as different from those of the arc light as are its optical properties. The lime light has a yellow tinge and the volume is large, making it impossible to converge the rays to a focus.

The arc light has the advantage over all other methods of illumination; its small cost per candle power, intensity, whiteness, and parallel rays make it especially well adapted for purposes of projection, as it admits a larger number of rays to pass through the optical centre of the condenser, and these rays can be brought to a perfect focus, thus producing a correct image with flatness of field, which is essential to produce sharp and well-defined pictures.

This matter of increased intensity is of the utmost importance, especially in large public halls where the pictures are enlarged many hundred times without regard to the diminished illumination produced by means of the oxyhydrogen light, which fails to bring out the details in the shadows, much to the disappointment of audience and producer of the slide. These considerations alone are enough to warrant its introduction for general use. When we consider that no skill is required in the operation of the lamp (other than to turn the switch and regulate the resistance), I feel that you will agree with me that the arc light, so many times denounced and said by some to be impracticable for projection, has now become indispensable for a progressive community.

At the close of the paper the Academy expressed its thanks to DR. LAUDY by a unanimous vote.

March 16th, 1891.

STATED MEETING.

About one hundred and twenty-five persons present.

In the absence of any of the officers, MR. P. H. DUDLEY was called to the chair.

The minutes of March 9th were read and approved.

MR. DUDLEY then introduced PROF. CHARLES SPRAGUE SMITH, of Columbia College, who delivered a lecture entitled

THE ORKNEYS AND SHETLAND,

illustrated by lantern slides from photographs taken by the lecturer.

At the close of the discourse a vote of thanks was extended to PROF. SMITH, and the meeting adjourned.

March 23d, 1891.

STATED MEETING.

VICE-PRESIDENT DR. HUBBARD in the chair.

About fifty persons present.

DR. HUBBARD announced that the meeting was called to form provisionally a Section of Ethnology, and asked for nominations for chairman and secretary.

DR. FREDERICK STARR and W. B. SCHOONMAKER were chosen; also a Committee on Permanent Organization, consisting of DRS. HUBBARD and STARR, and PROF. MARTIN.

DR. STARR then read a paper entitled

THE MAN OF THE STONE AGE.

(Abstract.)

What is meant by the Stone Age? Notice that it is a term descriptive of a stage of culture, not of a definite *time*. In Western Europe the Stone Age is easily distinguished into pa-

læolithic and neolithic periods. It is followed by the Bronze Age, and this by the Iron Age. These terms are all convenient, but must be used with care; and it must be remembered that this sequence is local, not universal.

How the stone tool is made.—(*a*) Chipping; three methods: 1, by blows; 2, by pressure; 3, by fire. Descriptions of these methods. (*b*) Polishing. (*c*) Drilling. Two kinds of drilled holes, one made by a solid drill, the other by a hollow drill. Skill in stone-tool making. Fine specimens of the work from Denmark, Ohio, Tennessee, etc.

The stone tool exerts an influence on the man of the Stone Age. (*a*) Affects the development of other arts. The carpentry of the Stone Age man. Hafting axe blades. Making boards. Cordage. Cements. (*b*) Leads to treaties and compacts. The pipestone quarry. Australian jade quarries. (*c*) Leads to the beginnings of trade. The contents of an Ohio mound. Red pipestone. (*d*) Leads to division of labor.

Examples of Stone Age man: (*a*) Of the olden times. The cave-dweller of France. (*b*) Of recent date. The Polynesians. The Alaskans. Modes of life. Acquisitions and attainments.

After the Stone Age notice two things: (*a*) The old tool becomes venerated. The folk-lore of stone tools. Curious beliefs regarding arrow-heads and celts. "Spiders lay the arrowheads," so the Sioux say. Celts and axes of stone fall from heaven and have healing virtue. (*b*) The old tool lingers on in religious rite after it has gone from every-day use. The conservatism of religion—*e.g.*, fire drill of Sacs and Foxes. The fire of Japanese priests. So we find the stone tool retained in ceremonies, as circumcision among Jews, blood-covenant of Arabs, and in embalming of Egyptians.

Thus we are debtors to the Stone Age man: (*a*) for a vast quantity of the greatest inventions and institutions; (*b*) for a mass of superstition, etc., which clings to us, and will for long years to come.

The paper was profusely illustrated with lantern slides of great interest.

A vote of thanks was accorded to PROF. STARR, and the meeting adjourned.

March 30th, 1891.

STATED MEETING.

VICE-PRESIDENT DR. HUBBARD in the chair.

About thirty persons present.

The minutes of March 23d, 1891, were read and approved.

DR. BOLTON read a communication from PROF. O. T. MASON, asking whether the point of 170th St., on the Hudson River, should be called Jeffrey's Hook or Fort Washington Point. [NOTE.—The Editor would be pleased to receive information from members and others on this topic.]

HON. WARREN HIGLEY was then introduced, and addressed the meeting on the proposed Adirondack Park, with special reference to the economic aspects. Further interesting remarks were made on the subject by DR. HUBBARD, Messrs. ROBERTS, HENDERSON, POTTER, POTTS, and GARRETTSON, and PROF. MARTIN.

It was voted that the Chairman should appoint a committee of three to draw up a petition to the Legislature, urging the passage of such bills as were now before them and which would tend to preserve the forest areas of the State.

DR. HUBBARD announced that he would appoint such committee before the next meeting.

April 6th, 1891.

REGULAR BUSINESS MEETING.

VICE-PRESIDENT DR. HUBBARD in the chair.

About twenty-five persons present.

The minutes of March 2d were read and approved.

DR. HUBBARD announced the following Committee on Forestry Legislation :

N. L. BRITTON.
FRANCIS T. GARRETTSON.
D. S. MARTIN.

The following recommendations of the COUNCIL (March 26th) were approved, and the member duly elected.

I. The report of the Conference Committee on the advisability of closer union with the other scientific societies of New York City:

CONFERENCE OF REPRESENTATIVES OF THE SCIENTIFIC ASSOCIATIONS.

Meeting of March 11th, 1891, American Museum of Natural History.

The Council of the New York Academy of Sciences having by resolution approved the report of a committee recommending a conference of representatives of the several scientific societies of New York, and the Secretary of the Academy having notified the secretaries of the other scientific societies of the action, and at the same time requesting the appointment of two delegates from each, a conference of these delegates, called by the Committee of the Council of the Academy of Sciences, was held at the American Museum of Natural History on Wednesday evening, March 11th, 1891.

The delegates appointed from each society were as follows:

From the New York Academy of Sciences: Mr. C. F. Cox, Dr. N. L. Britton.

From the Torrey Botanical Club: Dr. H. H. Rusby, Dr. Thomas Morong.

From the New York Microscopical Society: Rev. J. L. Zabriskie, Prof. J. D. Hyatt.

From the Linnæan Society of New York: Prof. J. A. Allen, Mr. G. B. Sennett.

From the Archæological Institute of America, New York branch: Prof. Allan Marquand, Mr. Russell Sturgis.

From the New York Mathematical Society: Dr. Emory McClintock; Dr. Thomas S. Fiske.

From the New York Mineralogical Club: Dr. E. S. F. Arnold, Mr. W. B. Schoonmaker.

The following delegates attended: Dr. Emory McClintock, Prof. J. A. Allen, Prof. J. D. Hyatt, Mr. C. F. Cox, Dr. E. S. F. Arnold, Mr. W. B. Schoonmaker, Dr. N. L. Britton.

Dr. Britton was elected Secretary of the Conference.

After an extended discussion of the means which might be taken to affiliate the several societies for mutual benefit and support, and to stimulate the progress of science in the city, it was unanimously resolved to submit the following recommendations to the societies:

1. The formation of a permanent organization, to be com-

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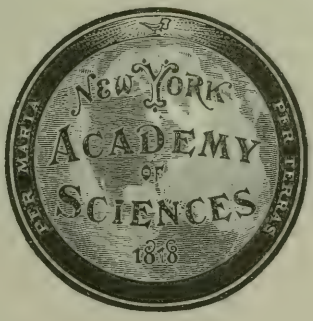

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posed of the president and two other members of each society, to act as a Joint Commission, having advisory powers only.

2. The preparation of an annual directory, giving the name and address of each member of each society, together with an indication of the societies of which he is a member. The expense of printing and distributing this directory to be divided among the societies pro rata to their membership, a copy to be sent to each member of each society.

3. The preparation of a periodical bulletin, to give the time and place of meeting of each society, and as far as possible the titles of papers to be read, lectures delivered, and such other information as may be deemed advisable. This bulletin to be sent to each member of each society, and the expenses connected with its preparation and distribution to be divided in the same manner as suggested for the directory.

4. The invitation of every member of each society to attend the ordinary meetings of all the societies as a guest.

5. That the secretary of each society be, and hereby is, requested to inform the Secretary of this Conference when action on these recommendations has been taken by the associations, and of the nature of such action.

Several other plans of action were discussed by the Conference, among them the desirability of obtaining a building for a common meeting place of all the societies, the possibility of arranging for a single annual due to give membership in all, the holding of periodical joint meetings to enable the members to become more generally acquainted, the arrangement of courses of scientific lectures. No action was taken on any of these topics.

The Conference then adjourned to the call of the Secretary.

N. L. Britton,
Secretary of the Conference.

II. The election of C. A. Post, Resident Member.

Prof. Britton introduced Mr. Heinrich Ries, a visitor, who read a paper entitled

NOTE ON ROCK EXPOSURE AT 143D AND 144TH STS. AND SEVENTH AVE.

Mr. Theo. A. Rand, of Philadelphia, in a communication to Prof. D. S. Martin, speaks of an outcrop of gneiss at 145th street and Seventh avenue, being mentioned by T. Sterry Hunt in his "Mineral Phys. and Phys." Being in New York City a short time ago, Mr. Rand visited this locality, and found a por-

tion of the outcrop remaining at 144th street and Seventh avenue. He remarks on the resemblance of the rock to the Manayunk schists of Hall, and suggests that it be examined.

I went up there and obtained photographs and specimens, and noted the following. The strata, of gray gneiss, are much contorted and show a number of synclinals, a large one, in the centre of the outcrop, being of a compact gneiss in which feldspar predominates. Scattered through the rock are segregated veins of pegmatite, while cutting directly across the strata, with a dip of 30° W., is a vein of granite. This vein may be seen on the south end of the outcrop, and also on the north side of 144th street.

At 143d street and Seventh avenue is an outcrop of a dark-colored, fine-grained mica schist. This outcrop also contains several granite veins, cutting *across* the strata, and one of them being *branched*. These two rock outcrops are thus specially interesting on account of these veins, which seem to be injected rather than segregated ones, with the exception of the pegmatite veins previously mentioned. The outcrops do not, as suggested by Mr. Rand, throw any further light upon the question of the exact geological age of the rocks of Manhattan Island.

The following papers were read by W. Goold Levison:

I. NOTE ON AN ECONOMICAL ZINC ELEMENT FOR BUNSEN BATTERIES,

illustrated by apparatus.

This modification consists in using a number of zinc plates clamped to a brass collar by set screws. It is claimed that by this means greater surface and consequently greater efficiency is gained. If one or more plates are used up, new ones may be inserted with ease, and need not interrupt the action of the apparatus.

II. NOTE ON PHOTOMICROGRAPHS FROM PHOTOGRAPHS OF LIGHTNING,

illustrated by lantern slides.

April 13th, 1891.

STATED MEETING.

Ten persons present.

In the absence of officers, PROF. BRITTON was chosen to preside.

The minutes of March 30th were read and approved.

The Secretary read an invitation from the New York Microscopical Society to their Twelfth Annual Reception, which was accepted.

The report of the Forestry Committee was read and adopted, and the Secretary was directed to mail a copy to the Legislature.

NEW YORK, April 9th, 1891.

The Committee appointed by the President to draft resolutions concerning the preservation of forest lands in the State of New York, would respectfully submit the following:

Whereas, The preservation of our remaining forest areas, and especially those in the region of the Adirondacks, is of immense importance to the business interests and the sanitary welfare of the citizens of the State, and should be secured by all safeguards of law; and

Whereas, Two bills prepared by the New York State Forestry Association are now before the Legislature for action, the one providing for important restrictions upon the building of railroads on forest lands belonging to the State, and the other prohibiting the construction of permanent dams, which have been so great a cause of forest destruction by overflow in recent years.

Resolved, That THE NEW YORK ACADEMY OF SCIENCES regards the provisions of these bills as wise, judicious, and timely, and deems their passage a matter of pressing importance; and

Resolved, That the ACADEMY would respectfully urge upon both houses of the Legislature the prompt adoption of these measures, as a step toward the protection of our forests and the maintenance of the conditions that all experience shows to be demanded by every requirement of an enlightened public policy.

D. S. MARTIN,
N. L. BRITTON,
J. J. GARRETTSON.

There being no announced paper, PROF. BRITTON made a few

remarks on the flora of South America, especially of the eastern slope of the Cordilleras of Bolivia, which section has been explored in recent years by Dr. Rusby.

April 20th, 1891.

STATED MEETING.

VICE-PRESIDENT PROF. ALLEN in the chair.

About one hundred persons present.

The minutes of April 13th were read and approved.

FRANCIS B. CROCKER, E.M., of Columbia College, was introduced, and delivered a lecture entitled

PRACTICAL APPLICATIONS OF ELECTRICITY,

illustrated experimentally.

At the close of the discourse a vote of thanks was tendered the lecturer, and the meeting adjourned.

April 27th, 1891.

STATED MEETING.

About twenty persons present.

In the absence of officers, PROF. REES was chosen to preside.

The minutes of April 20th were read and approved.

The minutes of the Section of Astronomy and the report of the Committee on Permanent Organization of the Section were read and approved.

The election of officers of the Section followed, resulting in the choice of J. K. REES as President, and E. H. JACOBY as Secretary.

PROF. REES took the chair and briefly addressed the Section.

The following paper was read, entitled

STELLAR PHOTOMETRY.

BY HENRY M. PARKHURST.

(Abstract.)

Estimations of the brightness of stars are liable to considerable error of judgment, causing an irregularity in the scale; and there is no tendency in the repetition of estimations to reduce this error. Any mode of measurement, however imperfect, if free from systematic errors, tends to make the scale of magnitudes uniform. The basis of photometric measures is the reduction of the observed star, by diminishing the aperture or by other means, either to invisibility or to equality of brightness with a standard star. The Meridian Photometer employed at Harvard Observatory compares the observed stars either with Polaris itself or with other standard polar stars previously compared with Polaris. This method appears to be free from systematic error, but has not yet been applied to the fainter telescopic stars. Various methods which have been employed to reduce the effective aperture were described, with the details necessary to secure accuracy. The illumination of the sky, whether by twilight, moonlight, or even by ordinary starlight, causes a large systematic error, unless this is specially provided against. The photometer used by the speaker in asteroid observations and in variable star observations avoids this difficulty by making the illumination the same with stars of all magnitudes. The logarithmic caps placed over the object-glass make the scale uniform. Other details described make bias impossible, bright stars and faint stars appearing precisely alike just before their extinction. This method has been employed for stars about two magnitudes fainter than could be measured with the Meridian Photometer.

Another mode of extinguishing observed stars is by the wedge, of neutral tint glass, which is capable of measuring stars nearly two magnitudes fainter still. But the scale of the wedge is so much affected by illumination that even a change of magnifying power causes a considerable change of scale. This method is especially adapted for occasional work, requiring very little apparatus and very little adjustment, but is purely differential, requiring standards to be well determined by other means. The paper concluded with a description of the apparatus by which the scale of the wedge could be determined with accuracy for stars too faint to be measured by other means.

May 4th, 1891.

REGULAR BUSINESS MEETING.

Held in the Chemical Lecture Room, School of Mines.

Twenty-one persons present.

In the absence of officers MR. MCCARTY was elected Chairman and DR. BRITTON Secretary pro tem.

The minutes of April 6th were read and approved.

DR. T. STERRY HUNT and DR. SIMON NEWCOMB were elected Honorary Members.

The following paper was read, entitled

ELECTRIC METERS.

BY L. H. LAUDY, PH.D.

Illustrated by diagrams, apparatus, and experiments.[1]

May 11th, 1891.

STATED MEETING.

VICE-PRESIDENT DR. HUBBARD in the chair.

Seven persons present.

The minutes of April 27th were read and approved.

JOSÉ G. AGUILERA, Escuela de Mineria, Mexico City, was proposed as Corresponding Member by GEORGE F. KUNZ.

There being no paper for the evening, the meeting adjourned.

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[1] The author explained to his audience most of the forms of apparatus used for measuring the electric energy for lighting purposes, comparing their accuracy with gas meters. He also spoke of the comparative cost and efficiency of illumination by oil, gas, and electricity.

May 18th, 1891.

STATED MEETING.

About one hundred persons present.

In the absence of officers, ADDISON BROWN was chosen to preside.

The minutes of May 11th were read and approved.

C. F. COX, A.M., was introduced, and delivered a lecture entitled

WHAT IS A DIATOM ?

illustrated by a large number of lantern slides. At the close of the discourse a vote of thanks was tendered to the lecturer, and the meeting adjourned.

May 25th, 1891.

STATED MEETING, ASTRONOMICAL SECTION.

PROF. REES in the chair.

About twenty-five persons present.

The minutes of the meeting of April 27th were read and approved.

The following paper was read, entitled

THE HISTORY OF LEXELL'S COMET FROM 1770 TO 1890.

BY CHARLES LANE POOR.

(No abstract.)

The paper illustrated the action of Jupiter and Saturn in drawing comets into the solar system.

June 1st, 1891.

REGULAR BUSINESS MEETING.

VICE-PRESIDENT DR. HUBBARD in the chair.

Eight persons present.

There being no quorum, the meeting was adjourned to the first Monday in October.

Before adjournment DR. BRITTON spoke of a curious occurrence of vertical needle-shaped ice crystals in limonite soil on Staten Island. These crystals were from two to three inches high, and the apices covered with soil, showing that they had been projected through the crust and had grown from below. Areas of many hundred square yards were covered with them. The crystals were deflected in the direction of the prevailing wind, and were smaller at the edges of the areas. Normally the ground was boggy. It is thought that this phenomenon is due to compression.

PROF. MARTIN announced the death of PROF. C. A. JOY, and was appointed a committee of one to draw up and present a suitable resolution.

Note by the Editor.

It is my painful duty to announce to the ACADEMY the death of the Librarian, DR. JOHN I. NORTHROP, the result of a distressing accident which occurred at Columbia College, June 27th, 1891.

DR. NORTHROP graduated from the School of Mines as a mining engineer in 1883. After some time spent in travel, he returned to this country and entered the Department of Geology of the School of Mines, occupying the position of Fellow and devoting his time to zoölogy. Recently he made a trip to the Bahama Islands, where he remained for several months, making a large collection of the flora and fauna of the section. His results are embodied in a paper read before the ACADEMY and published in the current volume of the TRANSACTIONS.

DR. NORTHROP was elected a member of the ACADEMY in 1887. In 1890 he was chosen Librarian, to fill the vacancy occasioned by the resignation of A. W. VOGDES, and re-elected this spring. DR. NORTHROP leaves a widow and child.

H. T. VULTÉ.

Errata.

TRANSACTIONS OF THE NEW YORK ACADEMY OF SCIENCES.
Vol. X., No. 1, page 23 :

For Mrs. Theodore Sutro read Mrs. Matilda Sutro.

Nos. 4–5, page 52 :

Line of article.	
8th	for Miniocichla read Mimocichla.
8th	for Gundlachi read gundlachi.
9th	for Glothlypis read Geothlypis.
12th	for Icturus read Icterus.
12–13th	for Northropi read northropi.
15th	for cocyzus minor Maynardi read Coccyzus minor maynardi.
15th	for Bahamensis read bahamensis.
17th	for Nycti corax read Nycticorax.
18th	for Coreyi read coryi.
18th	for Bahamensis read bahamensis.
19th	for Autrostomus Carolinensis read Antrostomus carolinensis.
23d	for Waterhousei read waterhousei.
1st	(p. 53) for cychera read cyclura.

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